Portable Storage Oscilloscope
PM3266

Instruction Manual/Gerätehandbuch/Notice d'emploi et d'entretien

9499 443 02302
811130/04/. .

S&I
Scientific & Industrial Equipment Division

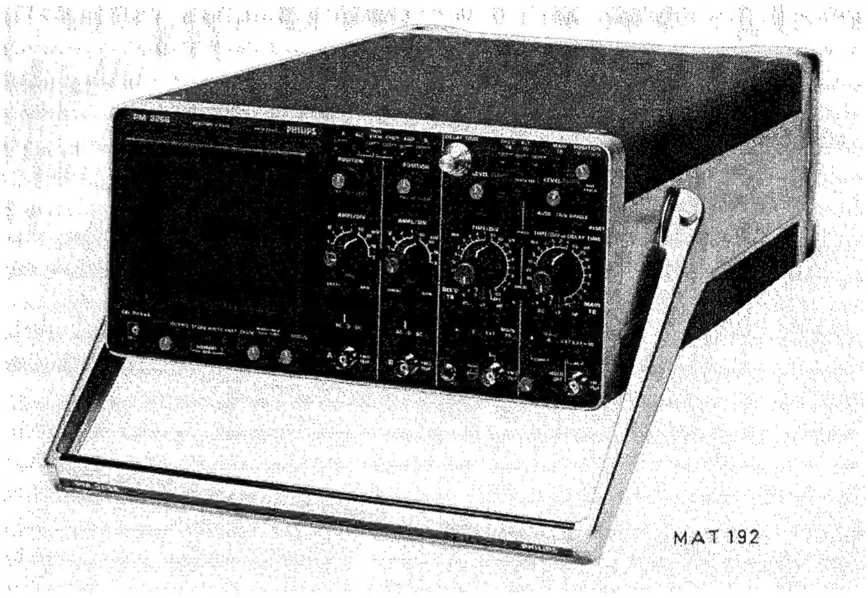
PHILIPS

PHILIPS

Portable Storage Oscilloscope
PM3266

Instruction Manual/Gerätehandbuch/Notice d'emploi et d'entretien

9499 443 02302
811130/04/. .



MAT 192

PHILIPS

IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

NOTE: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

BEMERKUNG: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparation)
Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

REMARQUES: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

PRINTED IN THE NETHERLANDS

CONTENTS

Page

FIGURES

INHALTSVERZEICHNIS (der Bedienungsanleitung)

ABBILDUNGEN

TABLE DES MATIERES (NOTICE D'EMPLOI)

FIGURES

CONTENTS SERVICE MANUAL

FIGURES

Operating Manual

1. GENERAL INFORMATION

1.1. INTRODUCTION

The PM 3266 is a portable storage oscilloscope with a very high writing speed (1000 DIV/μs). The instrument enables the measurement of signals at a high sensitivity (2 mV/DIV) over an extensive bandwidth (100 MHz). The oscilloscope has been designed using a large number of integrated circuits, which guarantee very stable operation and reduce the number of adjusting points. As an aid to checking and adjusting, test points have been included at appropriate positions around the circuit. The instrument features various storage functions such as normal and fast writing speed and auto erasure.

There is a wide choice of display possibilities, such as one channel, two channels alternately or chopped, two channels added with normal and inverted positions for both input signals, and a main and delayed time-base.
Additional features of the PM 3266 are the 3rd channel TRIG VIEW and ALTernate TB facilities.
TRIG VIEW enables the display of the trigger signal (internal or external applied) via a 3rd channel by push-button selection.
ALT.TB offers the instrument user a simultaneous display of the signal on the two time scale provided by the main time-base and the delayed time-base.
The PM 3266 oscilloscope features a tapless power supply that covers two voltage ranges, 100 V to 127 V and 220 V to 240 V by means of a switch, thus obviating the need for continuous adjustment to the local mains voltage.
All these features make the oscilloscope suitable for a wide range of applications.

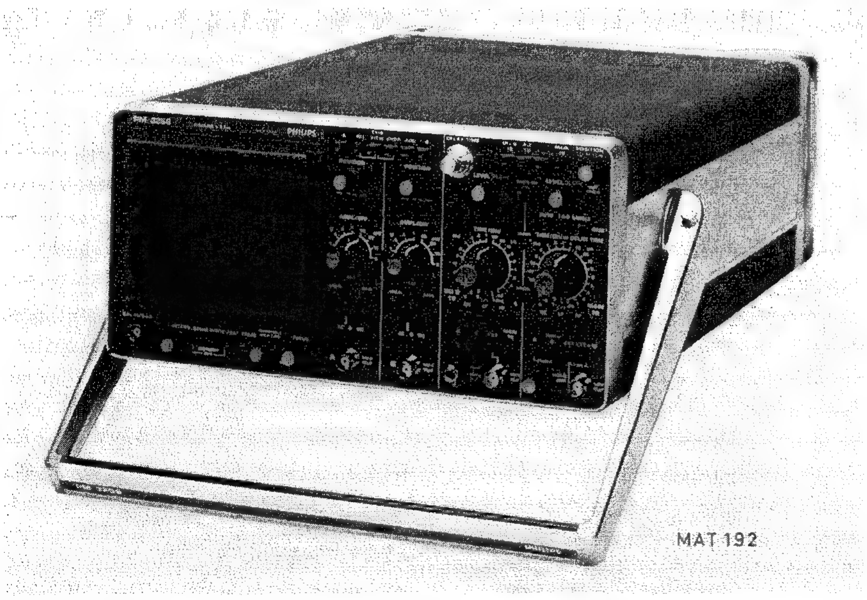


Fig. 1.1. Portable dual-trace Storage oscilloscope PM 3266

1.2. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class 1 instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings that shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).
- Properties expressed in numerical values with tolerance stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument.
- Inaccuracies (absolute or in %) relate to the indicated reference value.

1.2.1. CRT section

Designation	*Specification*	*Additional information*
CRT type	PHILIPS L14-140GH/95	Storage tube with high writing speed, image transfer and scan magnification in vertical direction. Rectangular tube face, post accelerator and metal-backed phosphor.
Useful screen area	8 x 10 DIV	1 DIV equals 0,9 cm. Vertical and horizontal straight lines shall be presented as straight lines on the c.r.t. in the central 7 x 9 DIV screen area.
Screen type	P31 (GH) phosphor	
Total acceleration voltage	10 kV	
Graticule	Internal	Non-illuminated
Engravings	Dotted lines at 1, 5 and 6,5 DIV from top of display provide measuring lattice for checking of rise-time	
Writing speed	1000 DIV/µs	In FAST mode. Not guaranteed for the square areas of 2 by 2 divisions in each screen corner
	2,5 DIV/µs	In WRITE mode and MAX position
	0,25 DIV/µs	In WRITE mode
Storage time	1 hour max.	In STORE mode: dependent on the position of the INTENS (brightness) control
	60 sec.	In the WRITE mode at max. intensity
	15 sec.	In the MAX WRITE mode at max. intensity
	15 sec.	In the FAST mode at max. intensity.
Persistence	0,3 sec ... 1 min	Operative in WRITE MODE. Continuously variable.
Auto Erase	Operative in Fast mode with VIEW TIME control out of the MAX position. View time continuously variable between 3 and 8 sec.	In the auto-erase mode the following cycle occurs: the stored picture is erased. If the time-base is triggered a new picture is written. After the adjusted view time another cycle starts and the picture is erased, etc. In the FAST mode the AUTO, TRIG and SINGLE pushbuttons are inoperative. Their function is taken over by the storage unit.
Erase time	1,3 sec. in WRITE mode 1,6 sec. in FAST mode	These values represent the time between the release of the ERASE button and the end of the erase cycle. The erase button resets the main time-base.
Trace rotation	Screw-driver adjustment point	Accessible via one of the ventilation holes on the left-hand side of the instrument

Designation		Specification	Additional Information
1.2.2.	**Vertical or Y axis**		
1.2.2.1.	*Response (2mV range excepted)*	For 2 mV spec. see 1.2.2. 13.	35 MHz at 2 mV
	Frequency range	d.c. to 100 MHz a.c. 7 Hz to 100 MHz	–3 dB bandwidth d.c. coupled –3 dB bandwidth a.c.coupled frequency range includes 10:1 probe over 20-30 °C
	Rise-time	3,5 ns	see fig. 1.5.
	Pulse aberrations	± 4% peak-peak	Over 6 divisions, +5 – 40°C
1.2.2.2.	*Deflection coefficient*	2 mV/div ... 5 V/div	(for 2 mV spec. refer to Section 1.2.2. 13.) Eleven calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : 2,5. Uncal. lamp signalling.
	Error limit	± 3%	Except linearity of CRT.
	Maximum permissible input voltage	± 400 V	d.c. + a.c. peak. Derating at frequencies above 500 kHz. See Fig. 1.2.
	Maximum undistorted deflection	24 divisions	Up to 35 MHz
	Shift range	16 divisions	8 divisions each in upward and downward direction from the central horizontal line of graticule.
1.2.2.3.	*Input impedance*	1 M Ω (± 2 %) // ≈ 15 pF	
	Input RC time	22 ms	Coupling to AC
1.2.2.4.	*Instability*		(for 2 mV/DIV setting refer to 1.2.2.13.).
	Instability of trace	0,1 div/hour	20-40 °C temperature range
	Trace jump	0,2 div	When switching between any of the attenuator positions
	Trace jump	0,5 div	When operating the NORM/INVERT switch
	Trace shift	0,2 div	When rotating the continuous attenuator 0,4 div in 5 mV setting
	Trace shift	1 div	When switching to the ADDED position. 0,4 div in 5 mV setting. Increasing when rotating the continuous attenuator.
1.2.2.5.	*Short-term temperature drift*	As 1.2.2.6.	
1.2.2.6.	*Long-term temperature drift*	20 μV/°C	Typical value
1.2.2.7.	*Visible signal delay*	15 ns approx.	
1.2.2.8.	*Display modes*	Channel + or – A only Channel + or – B only Trig. view only Channels ± A and ± B chopped Channels ± A and ± B alternated Channels ± A and ± B added ± A, ± B and Trig. view chopped or alternated (3 channels display)	If 3 channels display is selected in combination with alternate time-base display, this will be automatically displayed in main time-base intensified mode. Refer to 1.2.2.12. for full trig. view specification.

	Designation	*Specification*	*Additional Information*
1.2.2.9.	*Chopper frequency*	≈ 1 MHz	Display time per channel 350 ns approx.
1.2.2.10.	*Cross-talk between channels*	1:500	Up to 50 MHz With 8 divisions of signal amplitude on one channel, cross talk on other channel within line width, up to 35 Mc. Both attenuators in the same setting.
1.2.2.11.	*Common mode rejection factor*	Better than 100 up to 2 MHz 20 at 50 MHz	Measured with +A and –B added. Max. common-mode signal 8 divisions.
1.2.2.12.	*Trigger view display*	External or internal trigger signal.	
	Deflection coeff.	Same as vertical	
	External	100 mV/div ± 3 %	
	External ÷ 10	1 V/div ± 5 %	
	Internal	Vertical ± 10 %	
	Trigger point (threshold)	Screen centre ± 0,3 div	Coupling d.c.
	Aberrations	± 10 % peak-to-peak	
	Time delay between vertical input and external input	3 ns ± 1 ns	
	Bandwidth	80 MHz	Typical value
1.2.2.13.	*Specification of 2 mV/div setting*		
	a. Deflection coeff. Error limit	2 mV/div ± 5 %	
	b. Response Frequency range	DC 0 ... 35 MHz AC 7 Hz ... 35 MHz	–3 dB –3 dB
	Rise time	10 ns	
	Pulse aberration	± 5 % peak-to-peak	
	Common mode rejection factor	Better than 100 up to 2 MHz	
	c. Instability		
	Instability of trace	0,25 div/hour	20-40 °C temperature range
	Trace jump	1 div	When switching from 5 mV to 2 mV attenuator position
	Trace jump	2 div	When operating the Normal/Invert switch
	Trace shift	1 div	When rotating the continuous attenuator
	Trace shift	1 div	When switching to ADDED position

	Designation	Specification	Additional Information
1.2.3.	**Horizontal or X Axis**		
1.2.3.1.	*Display modes*	– Main time-base – Main time-base intensified by delayed time-base – Delayed time-base – Main TB intensified and delayed TB alternately displayed. – X-Y and X-Y/Y operation	With possibility of trace separation of 4 divisions. X deflection by: – channel A signal – channel B signal – signal applied to EXT connector of main TB – line voltage
1.2.3.2.	*Horizontal position drift in X1 position*	0,2 div/hour	The horizontal position drift with the magnifier in the X1 position, shall not exceed 0,1 div/hour over 20-40 °C temperature range. The same stability requirement applies to the start of the sweep during variation of the sweep speed setting, with exception of highest sweep ranges (50-100 ns/div).
1.2.3.3.	*Horizontal position control*	± 5,2 div from screen centre	The horizontal shift control combines coarse and fine adjustment.
1.2.4.	**Main Time-base**		
1.2.4.1.	*Operation*	Automatic	Automatic free running in the absence of triggering signals, after less than 0,1 sec.
		Triggered and single shot	
1.2.4.2.	*Time coefficient*	1 s/div ... 50 ns/div	23 calibrated positions in a 1-2-5 sequence Uncalibrated continuous control 1:>2,5 between the steps. One uncal. lamp for both MTB and DTB.
1.2.4.3.	*Coefficient error*	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C
	The difference in sweep accuracy over any two div.		The difference in sweep accuracy over any two divisions of 10 div sweep is ± 5 %, excluding the first and last div at the 5 ns and 10 ns magnified sweep rates.

	Designation	Specification	Additional Information
1.2.4.4.	*Expansion*		
	Magnification	10x	Switched, calibrated. The display when coinciding with the central vertical graticule line shall not shift more than one div when the horizontal magnifier is changed from X10 to X1
	Coefficient error	± 1 % additional	First and last 50 ns of 5 ns/div, 10 ns/div and 20 ns/div magnified sweep rates ± 5 %.
	Max. effective time coefficient	5 ns/div	
1.2.4.5.	*Variable hold-off time*	The sweep hold-off time can be increased by a factor of 10.	
1.2.5.	**Delayed Time base**		
1.2.5.1.	*Operation*	Delayed time-base starts optionally either immediately after the delay time, or upon arrival of the first trigger pulse after the delay time.	
1.2.5.2.	*Comparator long-term stability*	< 2 div at 1000 times magnification	With MTB at 1 ms/div and DTB at 1 µs/div a selected signal detail in the DTB mode shall not move more than two divisions after warm-up
1.2.5.3.	*Time coefficient*	0,5 s/div ... 50 ns/div	22 calibrated positions in 1-2-5 sequence Uncalibrated continuous control 1:2,5 between the steps. One uncal. lamp for both MTB and DTB.
1.2.5.4.	*Coefficient error*	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C The difference in sweep accuracy over any two divisions of 10 div sweep is ± 5 %, excluding the first and last div at the 5 ns and 10 ns magnified sweep rates.

	Designation	*Specification*	*Additional Information*
1.2.5.5.	*Delay-time*	Continuously variable between 0x and 10x the time coefficient of the MTB	Calibrated. Range delay-time multiplier 0,00-9,99 Incremental accuracy 0,5 % typical 0,2 %.
1.2.5.6.	*Delay-time jitter*	1:20.000	
1.2.6.	**X Deflection**		
	X deflection via channel Y_A or Y_B	2 mV/div ... 5 V/div	Uncalibrated continuous control 1:2,5 via Y gain potentiometer.
1.2.6.1.	*Coefficient error*	± 5 %	
1.2.6.2.	*Bandwidth*	0 - 2 MHz	–3 dB bandwith over 4 div. in horizontal screen centre!
1.2.6.3.	*Maximum undistorted delfection*	20 divisions	up to 100 kHz
1.2.6.4.	*Phase difference with respect to Y display*	3^{o} at 100 kHz	
	External X-deflection via EXT socket		
1.2.6.5.	*Deflection coefficient*		
	External	50 mV/div	Uncalibrated continuous control 1:3
	External ÷ 10	500 mV/div	
1.2.6.6.	*Accuracy*		
	External	± 3 %	Additional 2 % for Ext. :10
1.2.6.7.	*Bandwidth*	d.c. ... 2 MHz 7 Hz ... 2 MHz	Via DC trigg. coupling via LF or HF trigg. coupling
1.2.6.8.	*Input characteristics*	Identical to Y channels	
1.2.6.9.	*Phase difference Y-channels*	3^{o} at 100 kHz	
1.2.6.10.	*Linearity*	1,5 %	
1.2.6.11.	*Drift*	0,2 div./hr.	
1.2.7.	**Triggering of the main time-base**		
1.2.7.1.	*Trigger source*	Internal from channel A Internal from channel B Composite A and B Internal from line External source External source ÷ 10	 Alternate vertical mode only
1.2.7.2.	*Trigger modes*	Automatic	Automatic free-run of the time-base generator approx. 100 ms after disappearance of the trigger signal.
		Trigg. and single sweep	NOT TRIG'd lamp is illuminated after reset and extinguishes at the end of the sweep.
1.2.7.3.	*Slope*	+ or –	

	Designation	Specification	Additional Information
1.2.7.4.	*Trigger sensitivity*	Internal:0,5 div. upto 1,5 div. at 100 MHz	Typical sensitivity as a function of frequency, see Fig. 1.3.
		External: 50 mV upto 150 mV at 100 MHz	Typical sensitivity as a function of frequency, see Fig. 1.4.
		External÷ 10 : 500 mV up to 1,5V at 100 MHz	
1.2.7.5.	*Trigger modes and coupling*	DC: 0 - full bandwidth LF int: 0 - 30 kHz LF ext: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz AUTO: 20 Hz - full bandwidth	Both internal and external –3 dB –3 dB –3 dB, both internal and external
1.2.7.6.	*Level range*		
	internal trigg. external trigg. external :10	24 DIV +1,2 V to –1,2 V +12 V to –12 V	
1.2.7.7.	*Input characteristics*	1MΩ (± 2%) //≈ 15pF	
1.2.7.8.	*Trigger jitter*	Better than 0,5 ns	
1.2.8.	**Triggering of the delayed time-base**		
1.2.8.1.	*Source*	Internal from channel A Internal from channel B External	Other characteristics are identical to TRIGGERING OF THE MAIN-TIME BASE. Except Ext. :10 and line trigg.
1.2.9.	**Calibration unit**		
1.2.9.1.	*Output voltage*	3 V_{p-p}	
1.2.9.2.	*Output current*	6 mA	
1.2.9.3.	*Error limit*	± 1 %	Both voltage and current
1.2.9.4.	*Frequency*	2 kHz ± 2 %	
1.2.9.5.	*Protection*	The output is protected against continuous short-circuiting.	
1.2.10.	**Additional Input and Outputs**		
1.2.10.1.	*Z-modulation*	DC coupled TTL compatible Positive polarity Blanks display response time 35 ns input impedance 10 kΩ max. input voltage 50 V	
1.2.10.2.	*Main TB Gate*	0 ... +5 V delivered during MTB sweep	Optionally available Output impedance 1 KOhm.
1.2.10.3.	*Delayed TB Gate*	0 ... +5 V delivered during DTB sweep	Optionally available Output impedance 1 KOhm

	Designation	Specification	Additional Information
1.2.11.	**Power supply**		
1.2.11.1.	*Line voltage*	100 ... 127 VAC (± 10%) 220 ... 240 VAC (± 10%) 250 ... 350 VDC	Automatically protected against incorrect setting of line selector
1.2.11.2.	*Line frequency*	46 to 440 Hz	
1.2.11.3.	*Power consumption*	50 W	
1.2.11.4.	*Power transients*		Damage to the oscilloscope shall not occur under voltage and frequency transient conditions specified in MIL-T-28800.

1.2.12. Environmental characteristics

Note:

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

1.2.12.1. Temperature tests

In accordance with IEC 68 Ab and Bb.
Operation: –15 °C to +55 °C.
Operation within specification: +5 °C to +40 °C. Exceptions on tolerances to be indicated per spec. point.
Storage: –40°C to +70°C. Tested from –55°C to +75°C.

1.2.12.2. Altitude

In accordance with IEC 68-2-13 test M.
Operation: to 15.000 feet (5000 m)
Derating: 1 °C/1000 feet for the max. operating temperature
Storage: to 50.000 feet (17.000 m)

1.2.12.3. Shock

Operating: 30 g, half-sine, 11 ms duration, 2 shocks per axis per direction for a total of 12 shocks.

1.2.12.4. Vibration

Operating: 15 minutes along each of 3 axes.
0.025 inch p-p displacement (4 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute cycles.

1.2.12.5. Recovery

Operates within 30 minutes coming from –10 °C soak, going into room condition of 60 % R.H. at 20 °C.

1.2.12.6. Magnetic Shielding

In accordance with IEC 351 - 22.3.1.
A maximum deviation of 1 div.

1.2.12.7. Interference

VDE 0871 and 0875, störgrad K

1.2.13.	**Mechanical data**		
1.2.13.1.	*Dimensions*	Length 460 mm (16 1/4 in.) Width 316 mm (12 1/4 in.) Height 154 mm (6 1/8 in.)	Excluding controls, cover and feet
1.2.13.2.	*Weight*	10,9 kg (21 lbs)	

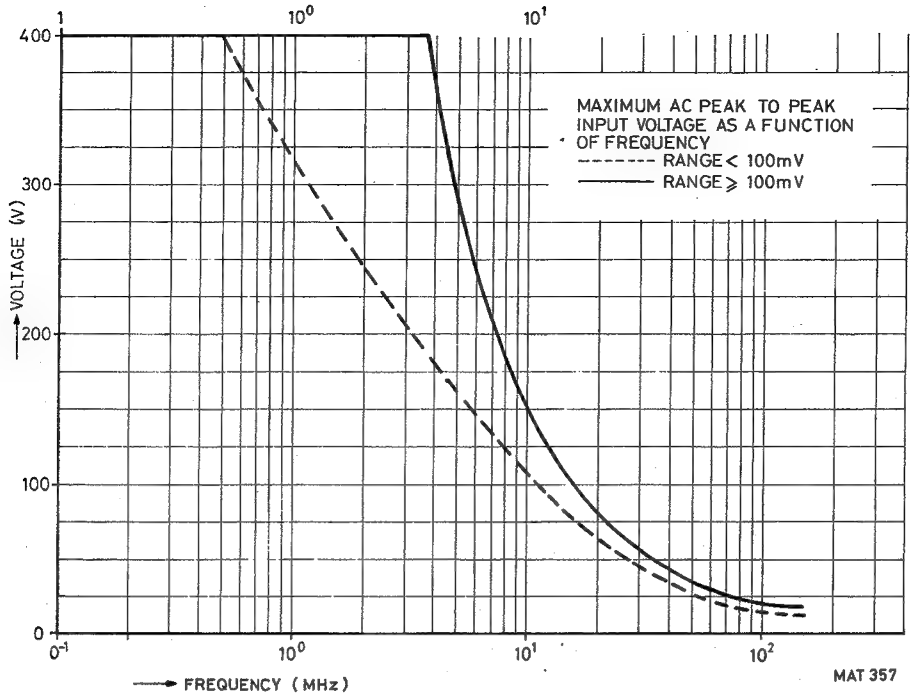


Fig. 1.2. Derating of the maximum permissible input voltage as a function of frequency

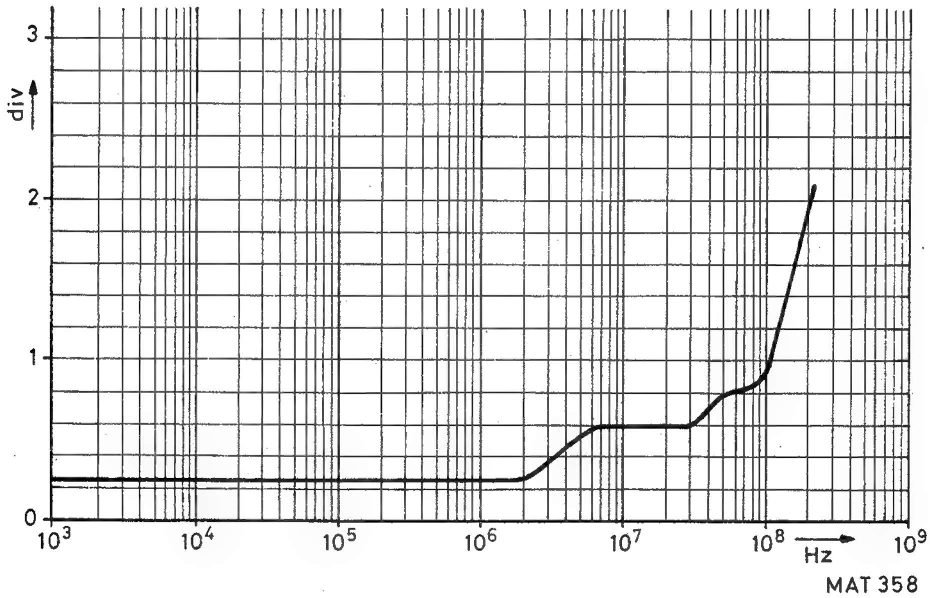


Fig. 1.3. Typical internal trigger sensitivity as a function of frequency

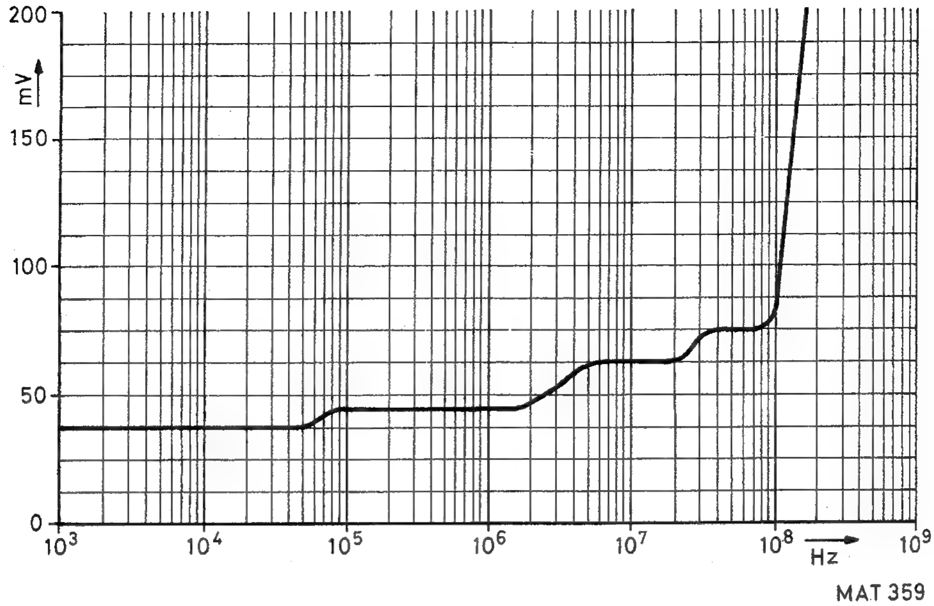


Fig. 1.4. Typical external trigger sensitivity as a function of frequency

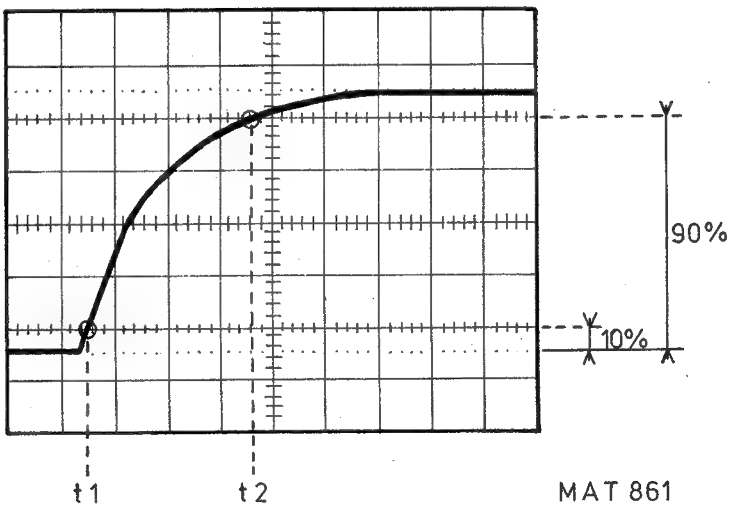


Fig. 1.5. Rise time measurement $t_R = t_2\,(90\%) - t_1\,(10\%)$

1.3. ACCESSORIES DELIVERED WITH THE INSTRUMENT

- Two passive 10:1 probes
- Contrast filter
- Front cover with storage space for e.g. probes
- Collapsible viewing hood PM 9366
- Banana/BNC adapter PM 9051
- Adaptor CAL terminal/BNC
- Manual

1.4. INFORMATION CONCERNING THE 10:1 PROBES DELIVERED WITH THE INSTRUMENT

This 10x attenuator probe is designed for the oscilloscopes PM 3262, PM 3263, PM 3264 and PM 3266.

1.4.1. Characteristics

Electrical

Attenuation	10x ± 2% (Oscilloscope input 1MΩ ± 1%)
Input resistance d.c.	10MΩ ± 2% (Oscilloscope input 1MΩ ± 5%)
a.c.	See curve Fig. 1.6.
Input capacitance d.c. and l.f.	11pF ± 1pF (Oscilloscope input 1MΩ ± 5% paralleled by 13pF ± 3pF)
Input reactance h.f.	See curve Fig. 1.6.
bandwidth	Probe has negligible effect on oscilloscope bandwidth
Max. input voltage	500V d.c. + a.c. peak, derating with frequency. See Fig. 1.7. Oscilloscope input 1MΩ and voltage applied between probe tip and earthed part of probe body. Test voltage $1500V_{d.c.}$ during 1s. at a temperature between 15 and 25°C, a rel hum. of 80% at maximum and at sea level.
Check-zero button probe shell	Same function as 0 position of input coupling switch on oscilloscope.

Environmental

Probe operates within specifications over the following ranges:

Temperature	−25°C to +70°C
Altitude	Up to 5000 metres (15000 feet)
Other environmental data	Same as for any PHILIPS oscilloscope the probe is used with

Mechanical

Dimensions	Probe body 103mm x 10mm dia (max.) Cable length 1500mm or 2500mm Correction box 55 x 30 x 15mm incl. BNC
Mass	Incl. standard accessories 125 g.

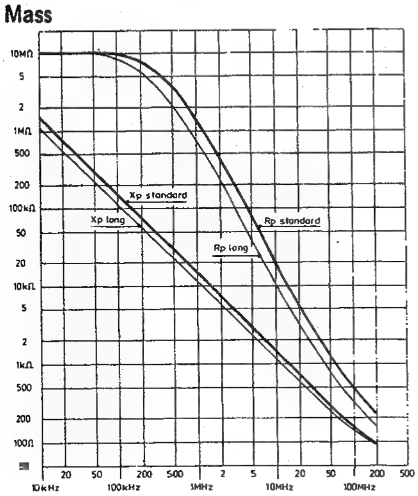


Fig. 1.6. Input resistance (Rp) and reactance (Xp) as a function of frequency

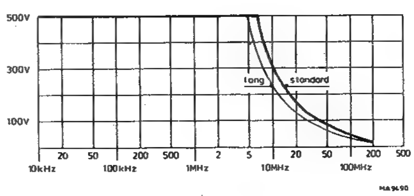


Fig. 1.7. Maximum AC component of input voltage as a function of frequency

1.4.2. Adjustments

Matching the probe to your oscilloscope

The measuring probe has been adjusted and checked by the manufacturer. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to the CAL socket of the oscilloscope.
A trimmer C2, can be adjusted through a hole in the compensation box to obtain optimum square-wave response.
See Fig. 1.8.b.

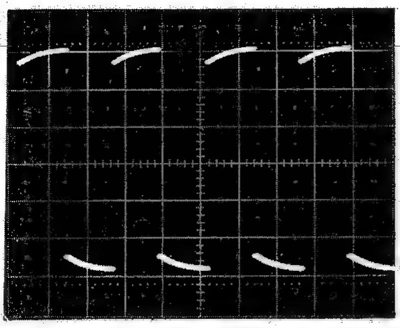


Fig. 1.8.a. Over-composition (adjustment C2)

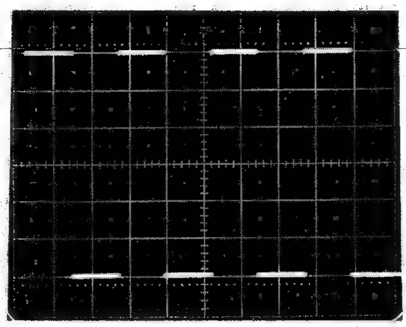


Fig. 1.8.b. Correct compensation (adjustment C2)

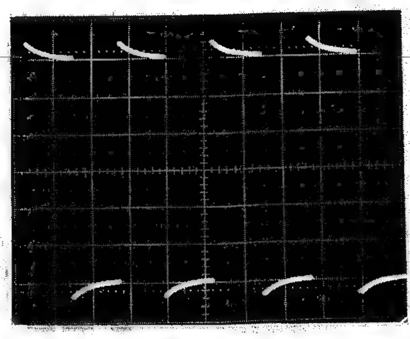


Fig. 1.8.c. Under-compensation (adjustment C2)

Adjusting the h.f. step response

The h.f. step response correction network has been adjusted by the manufacturer to match the oscilloscope input, so that adjustment of the h.f. response is normally not necessary.
Later readjustment is only necessary if the probe is to be used with a different type of oscilloscope, or after replacement of an electrical component.
For the adjustment, proceed as follows:
Connect the probe to a fast pulse generator (rise-time not exceeding 1 ns) which is terminated by its characteristic impedance. Dismantle the compensation box. Set the generator to 100kHz. Adjust R3 to obtain a display as shown in Fig. 1.9.a.
It is important that the leading edge is as streep, and the top is as flat, as possible. Incorrect setting of R3 gives rise to pulse distortions as shown in Fig. 1.9.b. and 1.9.c.

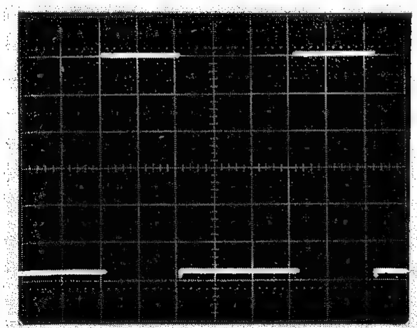


Fig. 1.9.a. Preset potentiometers correctly adjusted

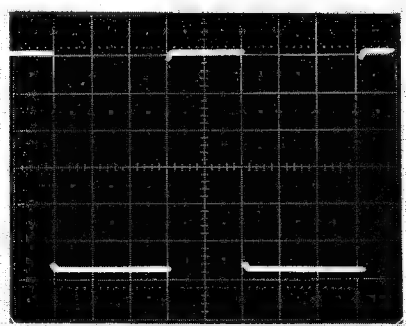


Fig. 1.9.b. Rounding due to incorrectly adjusted potentiometers

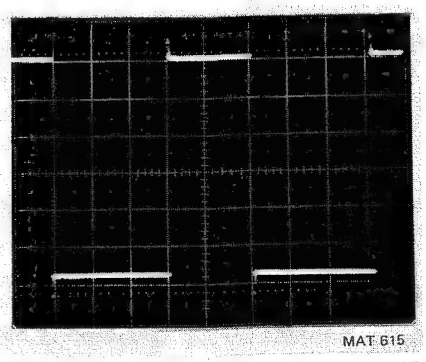


Fig. 1.9.c. Overshoot due to incorrectly adjusted potentiometers

For the location of adjustment point R3 on the p.c.b. in the compensation box, refer to fig. 1.12.

1.4.3. Dismantling

Dismantling the probe (see Fig. 1.10.).

The front part 11 of the probe can be screwed from the rear part 13. Item 11 can then be slid from 12 and 13.
The RC combination 12 is soldered to 13. For replacement of 12 refer to the next section.

Dismantling the compensation box (see Fig. 1.10.).

Unscrew the ribbed collar of the compensation box to the cable. The case 14 can then be slide sideways off the compensation box. The electrical components on the printed-wiring board are then accessible.

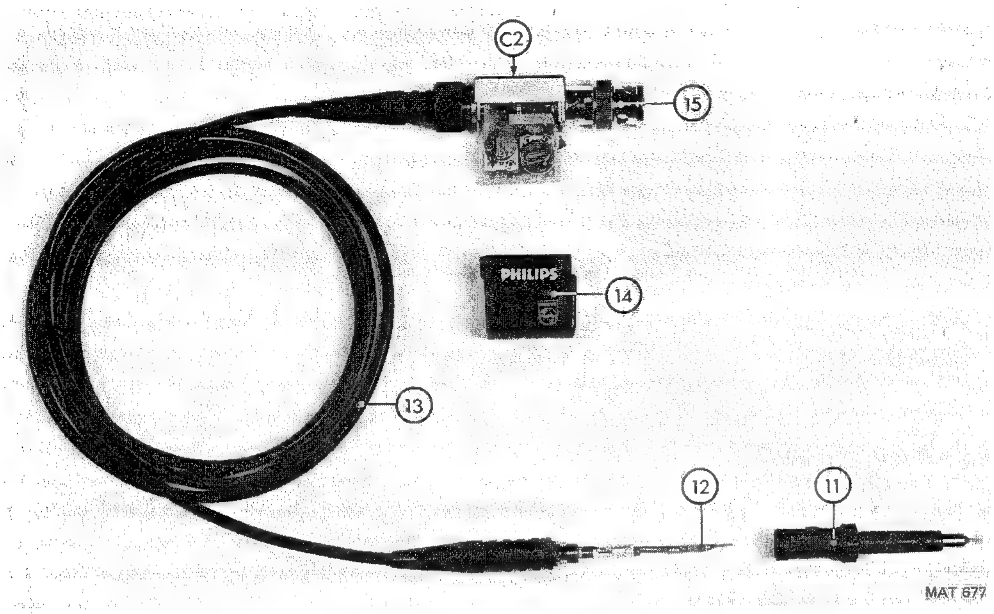


Fig. 1.10. Dismantling the probe

1.4.4. Replacing parts

Assembling the probe

A new RC network is slid over the cable nipple, after which the cable core is soldered on to the resistor wire. When the measuring probe is assembled, the RC network must be at dead centre in the probe tip.

Replacing the cable assembly

Dismantle the compensation box.
Unsolder the connection between the inner conductor and the printed-wiring board. Keep the frame of the compensation box steady and loosen the cable nipple with a 5 mm spanner on the hexagonal part. Replace the cable and fit it, working in the reverse order.

Replacing the BNC

Dismantle the compensation box.
Unsolder the connection to the printed-wiring board. Hold the frame of the compensation box firmly and loosen the BNC with a 3/8 inch spanner. Replace the BNC and fit it, working in the reverse order.

Replacing the probe tip

The damaged tip can be pulled out by means of a pair of pliers. A new tip must be firmly pushed in.

1.4.5. Parts list

1.4.5.1. Mechanical parts (see Fig. 1.10. and 1.11.).

Items 1 to 10 are standard accessories supplied with the probe.

Item	Order number	Qty	Description
1	5322 321 20223	1	Earth cable
2	5322 256 94136	1	Probe holder
3	5322 255 44026	5	Soldering terminals which may be incorporated in circuits as routine test points
4	5322 532 64223	2	Marking ring red
5	5322 532 64224	2	Marking ring white
	5322 532 64225	2	Marking ring blue (not shown)
6	5322 268 14017	2	Probe tip
7	5322 462 44319	1	Insulating cap to cover metal part of probe during measurements in densely wired circuits
8	5322 462 44318	2	Cap facilitating measurements on dual-in-line integrated circuits
9	5322 264 24018	1	Wrap pin adaptor
10	5322 264 24019	1	Spring-loaded test clip
11	5322 264 24021	1	Probe shell with check-zero button
12	5322 216 54152	1	RC network
13	5322 320 14063	1	Cable assembly
14	5322 447 64015	1	Cap
15	5322 268 44019	1	BNC connector

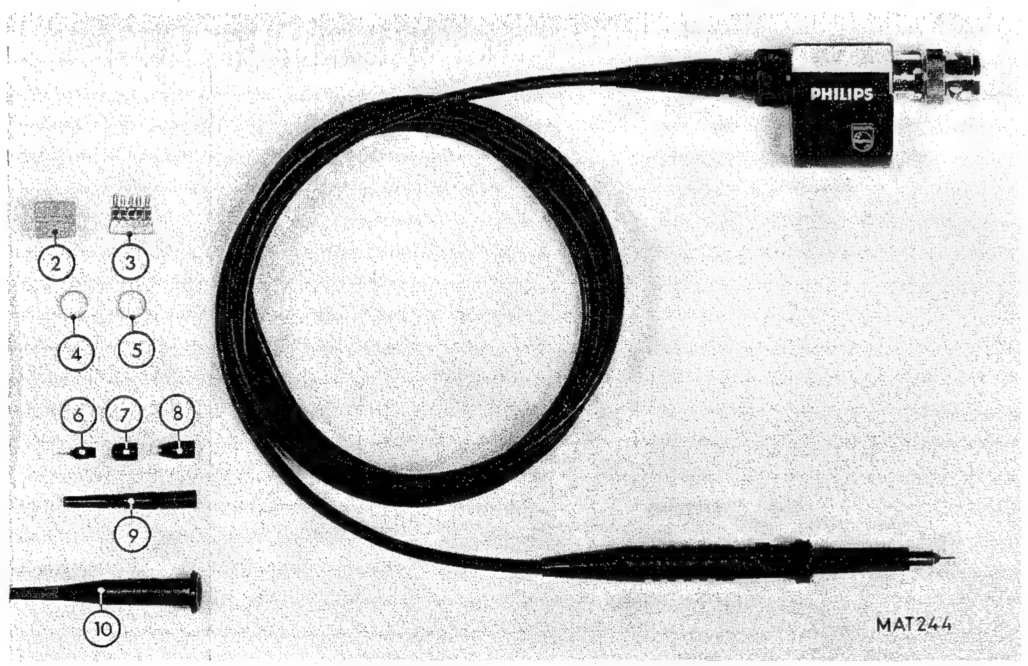


Fig. 1.11. Mechanical parts of the probe

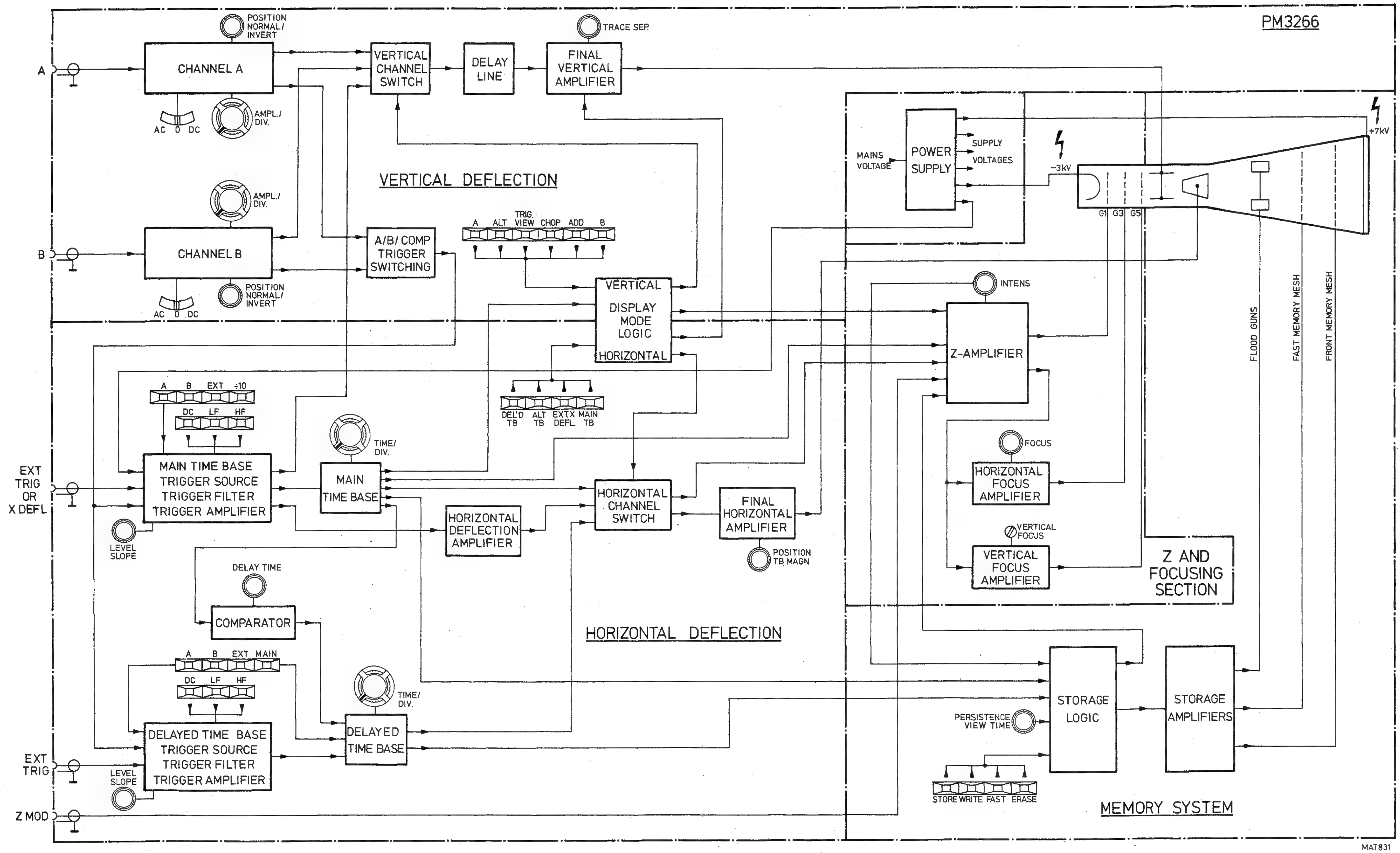
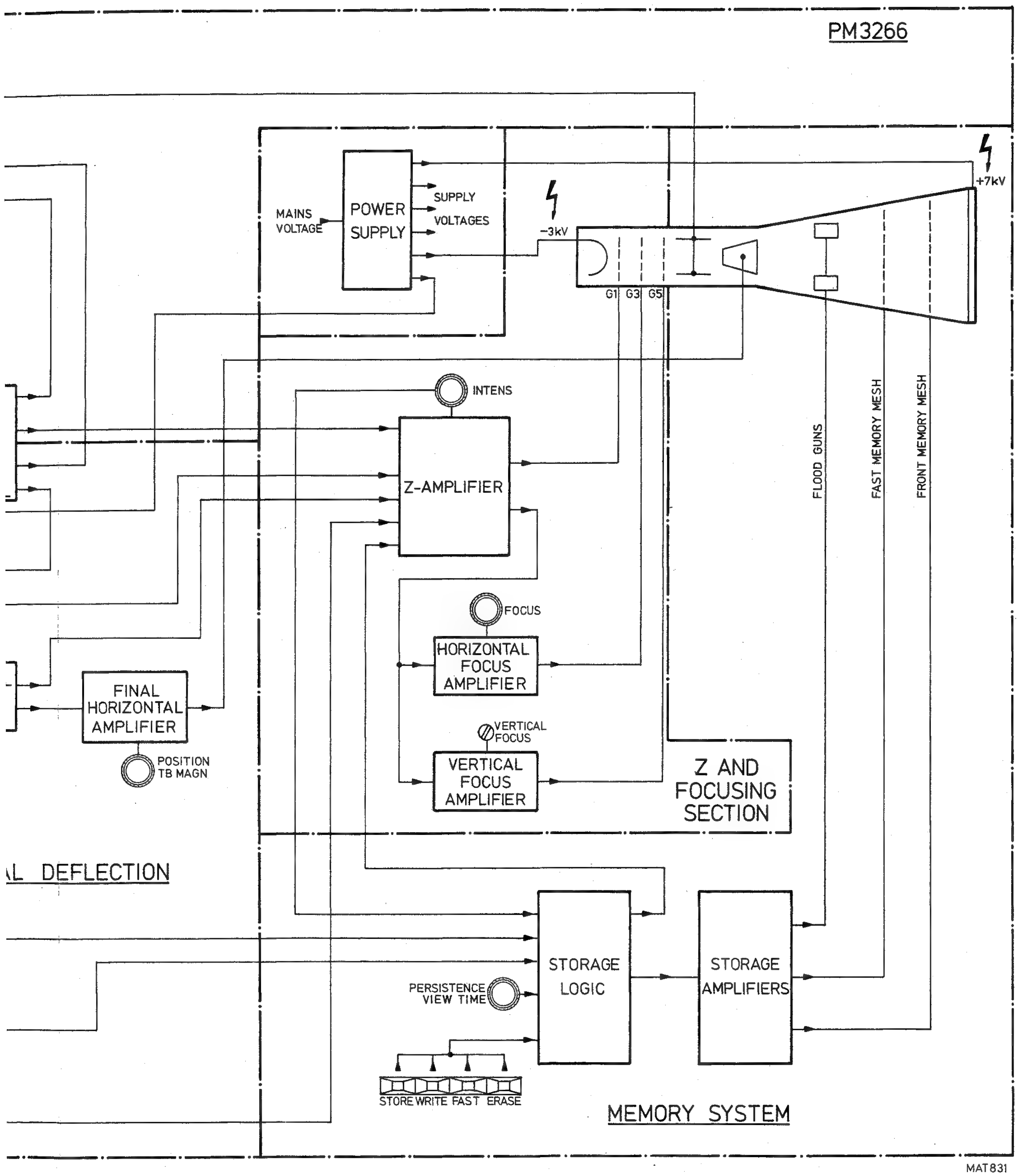


Fig. 1.13. PM3266. Functional block diagram.
Abb. 1.13. PM3266. Funktionelles Blockschaltbild.
Fig. 1.13. PM3266. Schéma synoptique de fonctionnement.



1.4.5.2. *Electrical parts (see Fig. 1.12).*

Item	Ordering Number	Description
C1	–	Part of RC-network (not supplied separately).
C2	5322 125 54003	Trimmer 60pF/300 V.
C3	–	Capacitor 2,7pF.
L1	–	Coil 5,5 windings, wire 0,4mm. diameter
R1	–	Part of RC-network (not supplied separately).
R2	5322 116 50536	Metal film resistor 464Ω, 1%, MR25
R3	5322 101 14047	Potmeter 470Ω, 20%
R4	5322 116 50536	Metal film resistor 464Ω, 1%, MR25
R5	5322 116 54462	Metal film resistor 82,5Ω, 1%, MR25

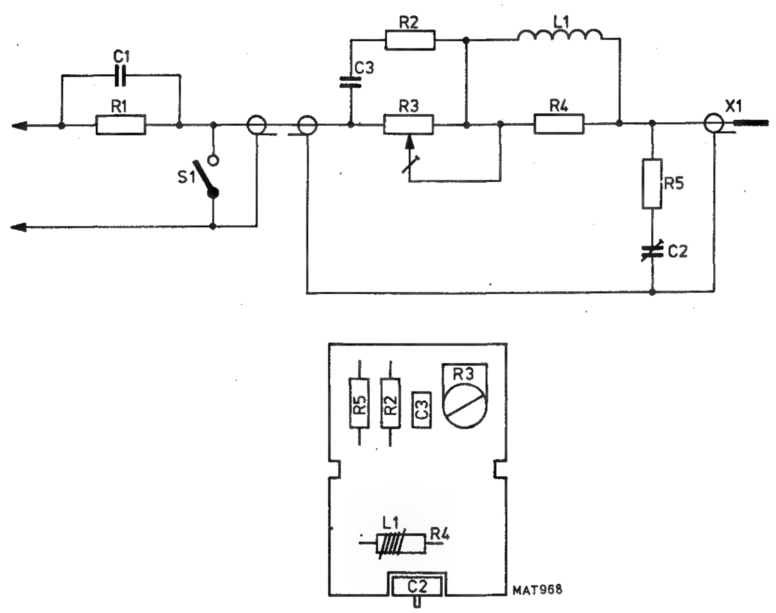


Fig. 1.12. Electrical parts and p.c.b. lay-out of the probe

1.5. DESCRIPTION OF FUNCTIONAL BLOCK DIAGRAM

1.5.1. Vertical deflection

The instrument has two identical channels A and B, each providing signal control and amplification for respectively the A and B input. For simplicity, only channel A is described.

CHANNEL A incorporates an AC/0/DC signal coupling switch, an AMPL/DIV control for adjusting the signal amplification to give the desired vertical trace height, and a POSITION control which also combines the NORMAL/INVERT function. In the three positions of the AC/0/DC switch the input signal is respectively applied to the amplifier input via a DC blocking capacitor (AC position), the input signal is interrupted (0-position) or the signal is directly coupled to the amplifier input (DC-position). The POSITION potentiometer provides continuous rotary control of the vertical shift of the signal on the screen; the push-pull control action enables the signal to be displayed either in the NORMAL or in the INVERTED polarity mode.

Time base triggering on a signal derived from one of the vertical channels is possible via the block A/B/ COMPOSITE TRIGGER SWITCHING.

The VERTICAL CHANNEL SWITCH is able to switch the CHANNEL A output signal through to the DELAY LINE and FINAL VERTICAL AMPLIFIER or to block this signal. Other signal sources for DELAY LINE and FINAL VERTICAL AMPLIFIER are the CHANNEL B output signal or the TRIGGER VIEW signal.
This signal is the signal on which the main time base triggers and its originates from the main time base trigger source.
If CHANNEL A and B are switched through simultaneously, the output signals of these channels are added and the sum is displayed on the screen.
The VERTICAL CHANNEL SWITCH is controlled by the VERTICAL DISPLAY MODE LOGIC that is operated by the vertical display mode switch A, ALT, TRIG VIEW, CHOP, ADD, B. If more than one channel is displayed the display can function in the CHOPped or the ALTernate display mode. A signal derived from the MAIN TIME BASE is used for the ALTernate display mode switching.

The DELAY LINE gives the necessary signal delay to enable the leading edge of a fast signal phenomenon to be displayed on the screen.

The FINAL VERTICAL AMPLIFIER drives the vertical deflection plates of the CRT. In the alternate time base mode the TRACE SEParation control enables an adjustable vertical trace shift between main and delayed time-base signals to facilitate comparison.

1.5.2. Horizontal deflection

Choice of input source for the FINAL HORIZONTAL AMPLIFIER can be selected from the MAIN TIME BASE, the DELAYED TIME BASE and the HORIZONTAL DEFLECTION AMPLIFIER.
Source selection is done by the HORIZONTAL CHANNEL SWITCH that is controlled by the HORIZONTAL DISPLAY MODE LOGIC. This logic is operated by the horizontal display mode switch DELD TB, ALT TB, EXT X DEFL, MAIN TB.

Both the MAIN TIME BASE and the DELAYED TIME BASE can generate a time-linear sawtooth voltage, the sweep time of which is adjustable by a TIME/DIV control.

MAIN TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER: the main time base can be triggered by channel A or B, a mains voltage related signal originating from the power supply or by a signal applied to the external trigger input EXT TRIG OR X DEFL. The desired trigger source can be selected by the trigger source switch. The selected source signal can be filtered by a LF filter, a HF filter or can be passed through unfiltered if the DC pushbutton of the DC/LF/HF switch is depressed. The level and the slope at which the main time base is started can be determined by the LEVEL/SLOPE control.
The selected main time base trigger source can also be used for horizontal deflection via the HORIZONTAL DEFLECTION AMPLIFIER and for TRIGger VIEW via the VERTICAL CHANNEL SWITCH.

DELAYED TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER: the delayed time base can be triggered by channel A or B or by a signal applied to the external trigger input EXT TRIG.
The signal coupling DC/LF/HF and LEVEL/SLOPE are adjustable.
The block marked COMPARATOR compares the main time base sawtooth waveform with an adjustable DC voltage derived from the DELAY TIME potentiometer. At the moment that the sawtooth voltage corresponds to the adjusted DC level the COMPARATOR sends a signal to the DELAYED TIME BASE.
If pushbutton MAIN TB of the trigger source selector is depressed the DELAYED TIME BASE now starts immediately. If pushbutton A, B or EXT of the trigger source selector is depressed the DELAYED TIME BASE starts after the signal from the COMPARATOR upon receipt of a trigger pulse from the selected trigger source.

1.5.3. Z and focusing section

The Z-amplifier receives input signals that determine the intensity of the spot on the screen via Wehnelt Cylinder G1 of the CRT. Moreover the focusing of the spot is influenced.
The CRT has separate electrodes for focusing in vertical direction (G5) and in horizontal direction (G3).
These electrodes are controlled by respectively the VERTICAL FOCUS AMPLIFIER and the HORIZONTAL FOCUS AMPLIFIER. Both amplifiers receive their input signal from the Z-AMPLIFIER.
The horizontal focus amplifier is controlled by the front panel control marked FOCUS.
The signals that control spot intensity and focusing are:

- the setting of the front panel INTENS control.
- a blanking signal for the chopped display mode originating from the vertical display mode logic.
- a blanking signal for display blanking during the main time base hold off period originating from the main time base.
- a signal originating from the HORIZONTAL CHANNEL SWITCH for the intensified part of the delayed time base signal on the main time base signal.
- a signal that can be applied to the external Z-modulation input marked Z-MOD.
- a signal from the MEMORY SYSTEM for display blanking when not writing in a signal.

1.5.4. Memory system and storage principle.

The instrument has a special storage tube. The storage system consists of a FRONT MEMORY MESH a FAST MEMORY MESH and the FLOOD GUNS.
Every storage mesh is a metal grid that is placed at a distance of a couple of millimeters behind the screen.
On the side of the grid that faces the writing system (cathode, G1, G3 and G5) a layer of dielectric material is present. The storage principle is based upon secondary emission in the dielectric layer. On places where high energy electrons from the writing system strike the memory mesh more electrons leave it than there were shot into it: these places are positively charged. The flood guns now procedure a cloud of low energy electrons, that cover the entire surface of the memory mesh. These electrons can pass the memory mesh on places where it has been positively charged.
When they have passed the mesh they are attracted by the very high positive voltage of the final accelerator.
In this way a replica of the charge pattern present in the memory mesh is displayed on the screen.

In the (MAX) WRITE mode only the front memory mesh is written in. This mesh has a writing speed, that is insufficient for fast signals. However the positive charge that is written in can persist for a long time.

In the FAST mode both the fast memory mesh and the front memory mesh are used. The fast mesh is composed in such a way that very fast signals can be written in. However the positive charge that is written in only persists for a short time. Therefore directly after the fast memory mesh has been written in (at the end of the time base sweep) the charge pattern is tranferred to the front memory mesh: this is called the image transfer. The transfer is carried out with the use of the electrons from the flood guns. After the transfer the replica of the charge pattern in the front memory mesh is displayed on the screen.

The image transfer is archieved by means of a number of pulses that are applied to front mesh, fast mesh and flood guns. Also for the erasure of the charge pattern in the memory meshes certain pulses must be applied to the electrodes of the memory system.
All the pulses necessary for good functioning of the memory system in the various modes are generated in the STORAGE LOGIC and afterwards amplified to the desired potential by the STORAGE AMPLIFIERS.
The storage logic is controlled by the mode selector STORE, MEMORY OFF, WRITE, FAST, ERASE and the controls PERSISTENCE/VIEW TIME and INTENS.

1.5.5. Power supply.

The mains power supply is stabilized and produces the DC supply voltages for the electronic circuits in the instrument, the high positive voltage for the first accelerator of the CRT, the high negative voltage for the cathode of the CRT. Moreover the power supply supplies a mains voltage related signal for trigger purposes of the main time base.

2. INSTALLATION INSTRUCTIONS

2.1. IMPORTANT SAFETY INSTRUCTIONS (IN ACCORDANCE WITH IEC 348)

Before connecting the instrument to the mains (line), visually check the cabinet, controls and connectors etc. to ascertain whether any damage has occurred in transit. If any defects are apparent, **do not** connect the instrument to the mains (line).

CLAIMS: In the event of obvious damage or shortages, or if the safety of the instrument is suspect, a claim should be filed with the carrier immediately. A Philips Sales or Service organisation should also be notified in order to facilitate the repair procedure.

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section 2.4. EARTHING).

WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals, which can be dangerous to life.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair is effected with the instrument open. If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazards involved. Bear in mind that the capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

2.2. REMOVING AND FITTING THE FRONT COVER (see fig. 2.1.)

Removing:

- Push and rotate the knob in the centre of the cover a quarter-turn anti-clockwise to the UNLOCKED position.
- Remove the cover.

Fitting:

- Push and rotate the knob to the UNLOCKED position.
- Fit the cover over the front of the oscilloscope.
- Press and rotate the knob a quarter-turn clockwise to the LOCKED position.

2.3. POSITION OF THE INSTRUMENT

The instrument may be used in any desired position. With the handle folded down the instrument may be used in sloping position. The electrical characteristics in accordance with chapter 1.2. are guaranteed for any position of the instrument. (Ensure that the ventilation holes in the top and bottom covers are free). Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.
The carrying handle can be rotated if the push-buttons on its bearings are depressed.

Fig. 2.1. Removing Front Cover

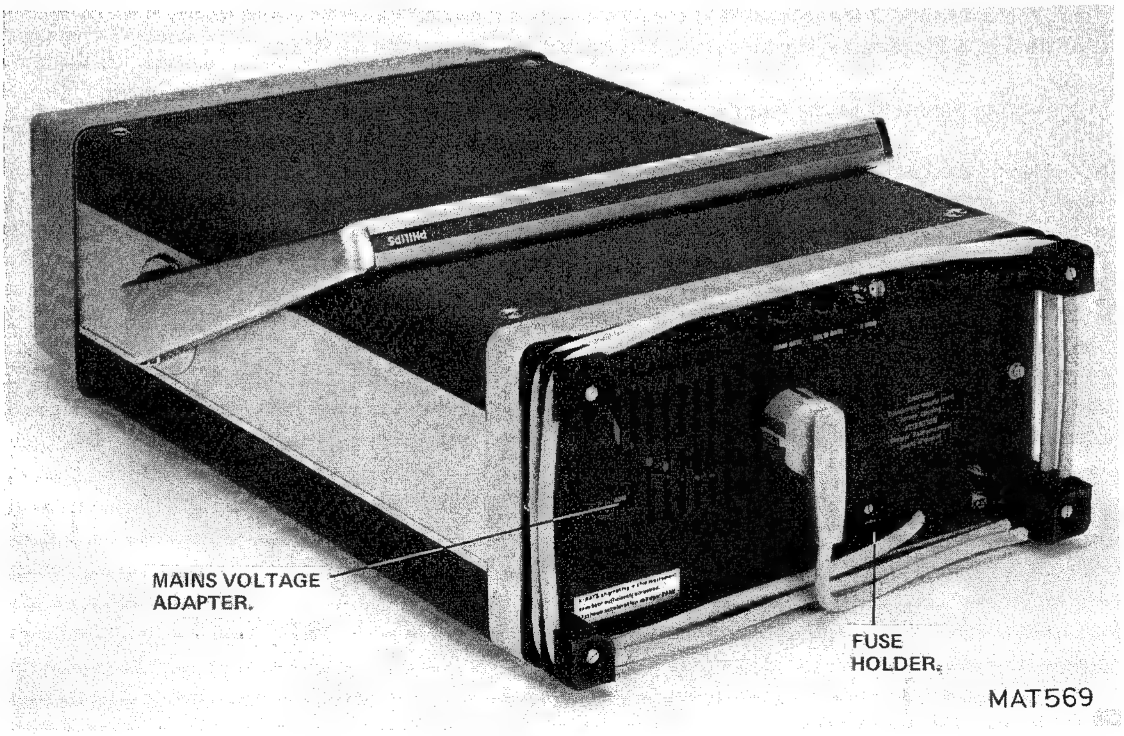


Fig. 2.2. Rear view of the instrument

2.4. EARTHING

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- via the protective earth terminal
- via the three-core mains cable. The mains plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

WARNING:	Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth teminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

2.5. MAINS VOLTAGE SETTING AND FUSE

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.
The instrument can operate on two mains voltage ranges: 100 ... 127 VAC (± 10%) and 220 ... 240 VAC (± 10%). The latter voltage range is also used when the instrument is operated by a DC voltage between 250 and 350 Volt. Either of the two voltage ranges can be selected by means of the slider switch that is located behind the window in the rear plate of the instrument. The selected voltage range is visible through this window, see figure 2.2.
Disconnect the instrument from all voltage sources before attempting to gain access to the voltage selector switch.
The switch is accessible if the rear plate of the instrument is removed (unscrew two screws).
The instrument is protected against incorrect setting of the mains voltage selector.

The fuse-holder mounted on the rear panel carries a 2A delayed-action fuse.

When replacing a fuse make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders must be avoided. The instrument must be disconnected from all voltage sources when a fuse is to be replaced or when the instrument is to be adapted to a different mains voltage.

3. OPERATING INSTRUCTIONS

3.1. GENERAL INFORMATION

This section outlines the procedures and precautions necessary for operation. It identifies and briefly describes the functions of the front and rear panel controls and indicators, and explains the practical aspects of operation to enable an operator to evaluate quickly the instrument's main functions.

3.2. SWITCHING ON

After the oscilloscope has been connected to the mains(line) voltage in accordance with chapters 2.4. and 2.5., it can be switched on with the POWER switch. This switch is incorporated in the graticule ILLUM control on the front-panel, immediately below the screen bezel. The associated POWER ON/OFF indicator lamp is adjacent to the ILLUM control. When switching on the oscilloscope, it is immediately ready for use. With normal installation, according to section 2, and after a warming-up time of 30 minutes, the characteristics according to chapter 1.2. are valid.

WARNING:	The oscilloscope must never be switched on whilst any circuit board is removed. Never remove a circuit board until the oscilloscope has been switched-off for at least one minute.

3.3.

3.3.1.

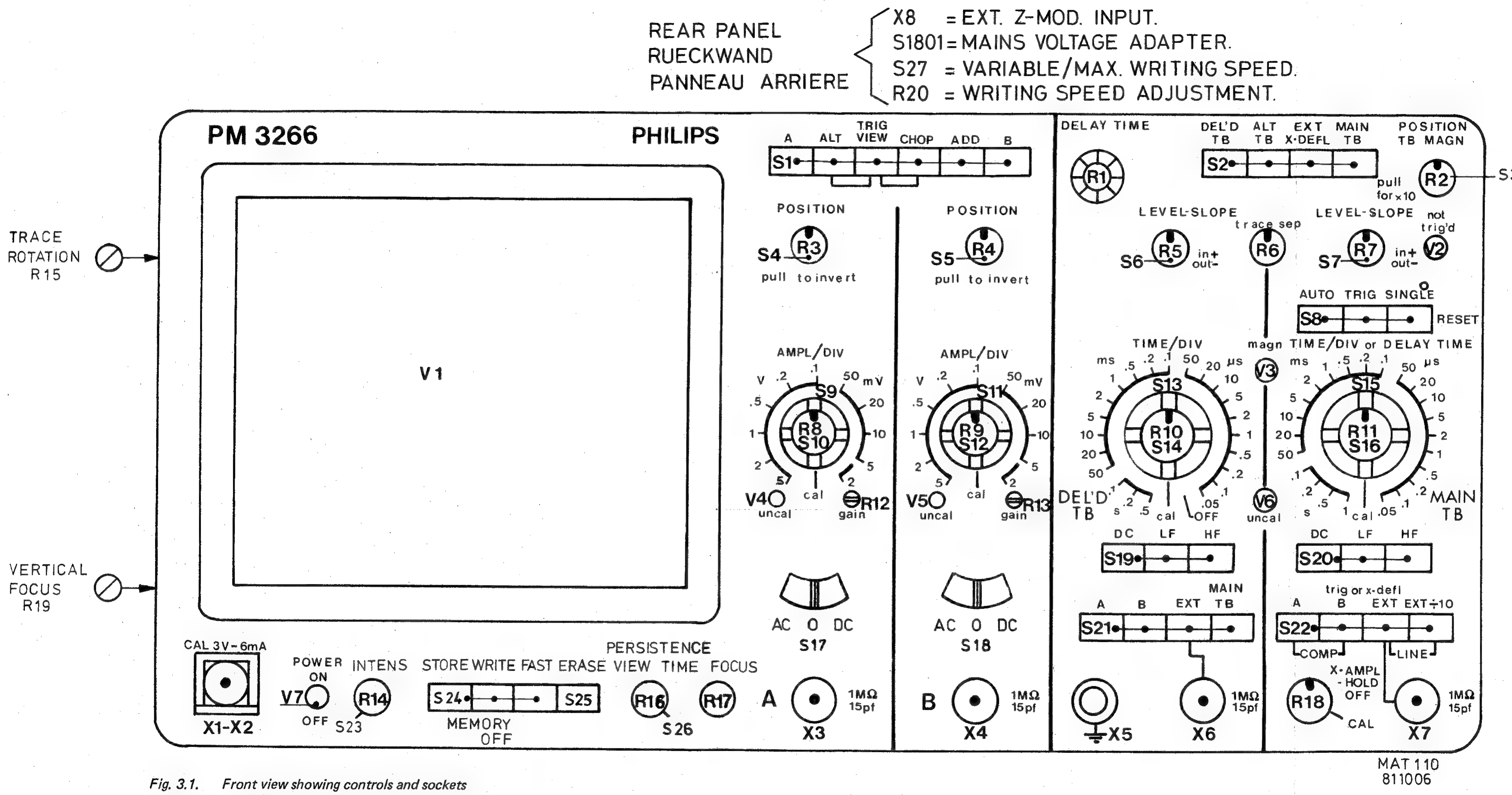
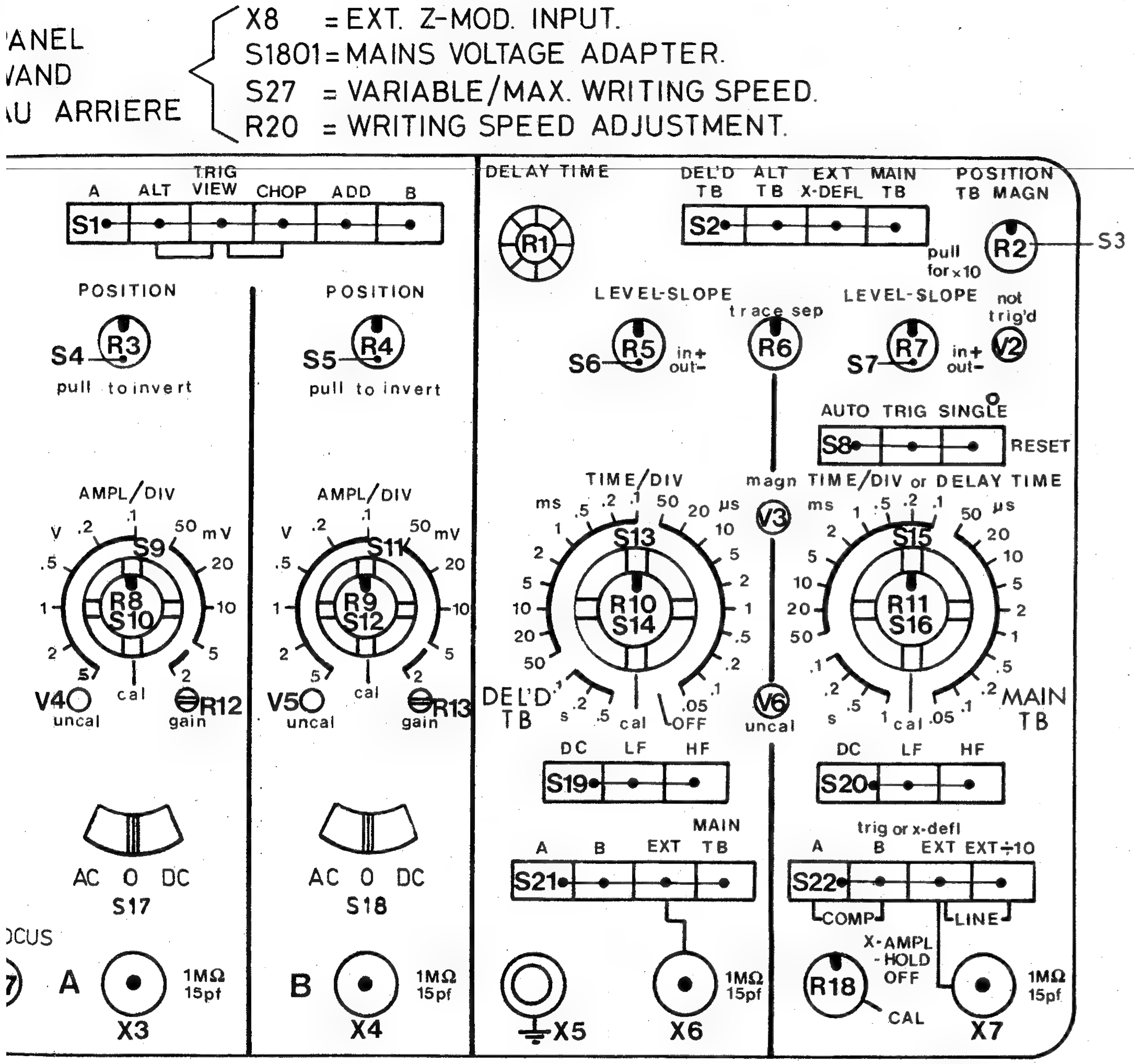


Fig. 3.1. *Front view showing controls and sockets*
Abb. 3.1. *Vorderansicht mit Bedienungsorganen und Buchsen*
Fig. 3.1. *Vue avant montrant les commandes et douilles*



MAT 110
811006

3.3. EXPLANATION OF CONTROLS AND SOCKETS (See Fig. 3.1.).

3.3.1. Vertical channels

A, ALT, TRIG VIEW, CHOP, ADD, B (S1)	Vertical display-mode controls; 6-way push-button switch.
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal; i.e. the A and B channels are displayed on ALTernate sweeps.
TRIG VIEW depressed	The display is switched to view the selected trigger signal. Trigger view display can be internal via A or B channels (A or B of S22 depressed) or external via external input socket X7, when EXT or EXT ÷ 10 of S22 is depressed.
CHOP depressed	The display is switched over from one vertical channel to the other at a fixed frequency, both A and B channels being displayed during the same sweep.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B.
All pushbuttons normal	If no push-button is depressed, the instrument operates in the ALT mode.
ALT and TRIG VIEW depressed simultanuously	The signals on channels A, B and TRIG VIEW are displayed during alternate sweeps; usually suitable for high frequency signals (see also explanation of push-button TRIG VIEW)
CHOP and TRIG VIEW depressed simultaneously	The signals on channel A, B and TRIG VIEW are displayed one after the other at the CHOP frequency during the same sweep; usually suitable for low frequency signals. (See also explanation of push-button TRIG VIEW)
POSITION (R3, R4)	Continuously variable control giving vertical shift of the display.
PULL TO INVERT (S4, S5)	2-way push-pull switch, integral with the POSITION control, for the inversion of the signal polarity. Control is depressed for NORMAL and pulled for INVERT.
AMPL/DIV (S9, S11)	Step control of the vertical deflection coefficients; 11-way switch.
CAL (AMPL/DIV) (R8/S10, R9/S12)	Continuously variable control of the vertical deflection coefficients. In the CAL position the selected deflection coefficient is calibrated
UNCAL (V4, V5)	Pilot lamp indicating that the CAL control is not in the CAL position.
GAIN (R12, R13) (screw-driver control)	Continuously variable preset control of the overall gain of the vertical channels.

AC, 0, DC (S17, S18)	Signal input coupling; 3-way switch
AC position	Coupling via a blocking capacitor
0 position	Connection between input circuit and input socket is interrupted and the amplifier input is earthed to establish a reference.
DC position	Direct coupling With no button depressed, the circuit operates effectively as if the AC button is depressed, When viewing long duration pulses or d.c. levels of waveforms, the DC position should be selected. For a.c. waveforms with large d.c. levels, the AC position should be selected.
A, 1 MΩ//15 pF (X3)	BNC input socket for channel A.
B, 1 MΩ//15 pF (X4)	BNC input socket for channel B.

3.3.2. Horizontal channels

DEL'D TB, ALT TB, EXT X DEFL, MAIN TB (S2)	Horizontal displaymode or deflection controls; 4-way push-button switch.
DEL'D TB depressed	The horizontal deflection voltage is supplied by the delayed time-base generator.
ALT TB depressed	The horizontal display is switched over from the main time-base to the delayed time-base at the end of every cycle of the main time-base generator. Not functioning when TRIG VIEW is depressed or when the delayed time-base is switched to OFF.
EXT X DEFL depressed	Horizontal deflection is achieved by a signal applied to the external input socket (X7) of the horizontal amplifier, by the channel A or B signals, the composite signal, or by a mains-frequency (LINE) signal, depending on the TRIG or X DEFL push-button (S22) selection.
MAIN TB depressed	The horizontal deflection voltage is supplied by the main time-base generator. A part of the trace is intensified (except in the OFF position of the TIME/DIV switch of the delayed time-base generator). **No push-button depressed** is effectively the same as MAIN TB depressed.
POSITION TB MAGN (R2, S3)	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch for increasing the horizontal deflection coefficient by a factor of 10 (PULL FOR X10).
MAGN (V3)	A pilot lamp indicating that the X10 magnifier is in operation.
X-AMPL, HOLD-OFF (R18)	Continuously variable control of the horizontal deflection coefficients when using external X deflection. In the case of X deflection by the main time-base, this control can be used to increase the sweep hold-off time.
TRACE SEP. (R6);	Continuously variable preset control of the vertical space between the two time-base displays in the ALT TB mode.

3.3.3. Main time-base generator

LEVEL-SLOPE (R7, S7)	Continuously variable control for selecting the level of the triggering signal at which the time-base generator starts. This control incorporates a push-pull switch that enables choice of triggering on either the positive- or negative-going edge of the triggering signal (IN +, OUT –).
NOT TRIG'D (V2)	Pilot lamp indicating that the time-base generator is in the waiting position. The lamp is continuously on in the fast mode.

AUTO, TRIG, SINGLE (S8)	Trigger-mode controls; 3-way push-button switch.
AUTO depressed	The main time-base is free-running in the absence of trigger signals.
TRIG depressed	The time-base generator is normally triggered.
SINGLE depressed	After depressing the SINGLE button, the time-base generator runs only once upon receipt of a trigger pulse. If no button is depressed the circuit operates effectively as if the SINGLE mode has been selected.
TIME/DIV or DELAY TIME (S15)	Time coefficient control of the main time-base; 23-way rotary switch.
CAL (blue) - TIME/DIV (R11, S16)	Continuously variable control of the main time-base coefficients. In the CAL position the time coefficient is calibrated.
UNCAL (V6)	Pilot lamp indicating that the CAL control is not in the calibrated position.
DC, LF, HF (S20)	Trigger coupling; 3-way push-button switch.
DC depressed	Triggering signals are direct-coupled.
LF depressed	Trigger coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 7 Hz to 30 kHz).
HF depressed	Trigger coupling via a high-pass filter for frequencies higher than 30 kHz. With no push-button depressed, the circuit operates effectively as with the DC button depressed.
TRIG or X-DEFL (S22)	Trigger source or external X deflection selector; 4-way push-button switch. X-deflection only when push-button EXT X DEFL of S2 (horizontal display-mode controls) is depressed.
A depressed	Internal triggering or X deflection signal derived from channel A.
B depressed	Internal triggering or X deflection signal derived from channel B.
COMP (A and B depressed simultaneously)	Internal triggering or X deflection signal derived from channels A and B.
EXT	Triggering on external signal connected to the adjacent 1 M - 15 pF socket (X7). When the EXT X DEFL button of the horizontal deflection controls is depressed, this socket is connected to the input of the horizontal amplifier.
EXT ÷ 10	EXT triggering or X deflection facilities as above, attenuated by a factor of ten.
LINE (EXT and EXT ÷ 10 depressed simultaneously)	Triggering or X deflection signal derived from an internal voltage at mains frequency. If no button is depressed, no mode is selected.
1 MΩ//15 pF (X7)	BNC socket for external triggering or horizontal deflection

3.3.4 Delayed time-base generator

DELAY TIME MULTIPLIER (R1)	Continuously variable control of the delay time, operating in conjunction with the TIME/DIV controls of the main time-base generator.
LEVEL-SLOPE (R5, S6)	Continuously variable control for selecting the level of the triggering signal at which the delayed time-base generator starts.

	This control incorporates a push-pull switch that enables choice of triggering on the positive or negative-going edge of the triggering signal (IN +, OUT –).
TIME/DIV (S13)	Time-coefficient control of the delayed time-base; 23-way rotary switch. Incorporates an OFF position whereby the delayed time-base is switched off.
CAL (blue) - TIME/DIV (R10, S14)	Continuously variable control of the delayed time-base generator time coefficients. In the CAL position the time coefficient is calibrated.
UNCAL (V6)	Pilot lamp indicating that the CAL control is not in the calibrated position.
DC, LF, HF (S19)	Trigger coupling; 3-way push-button switch.
DC depressed	Triggering signals are direct-coupled.
LF depressed	Trigger coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 7 Hz to 30 kHz).
HF depressed	Trigger coupling via a high-pass filter for frequencies higher than 30 kHz.
	With no push-button depressed, the circuit operates effectively as with the DC button depressed.
A, B, EXT, MAIN TB (S21)	Trigger source control and starting point of delayed time-base 4-way push-button switch.
A depressed	Internal triggering signal derived from channel A after delay time.
B depressed	Internal triggering signal derived from channel B after delay time.
EXT depressed	Triggering after delay time on an external signal connected to the adjacent 1 M - 15 pF socket.
MAIN TB depressed	Delayed time-base starts immediately after delay time.
	With no button depressed, the circuit operates effectively as with the channel A button depressed.
1 MΩ//15 pF (X6)	BNC input socket for external triggering signals.

3 3.5. CRT display section

INTENS/POWER ON	Mains ON/OFF switch with LED indication if the instrument is switched on. In the (MAX) WRITE, FAST or MEMORY OFF mode: the position of the knob determines the intensity of the waveform that is written on the storage layer of the c.r.t. In the STORE mode: the position of the knob determines the brightness of the reproduced waveform on the c.r.t. screen. If the brightness is increased the storage time decreases.
STORE/WRITE/FAST/ERASE (MEMORY OFF)	Pushbutton switches for the control of the storage system.
STORE	Enables recorded waveform to be stored for a longer time than available with the PERSISTENCE control. The INTENS control is operative.
WRITE	Enables waveform to be recorded at normal writing speed. The PERSISTENCE and INTENS controls are operative.

FAST

Enables waveform to be recorded at high writing speed. The VIEW TIME and INTENS controls are operative.

ERASE

Enables erasure of the waveform that is written on the storage layer of the c.r.t. This control is not effective in the STORE mode.

MEMORY OFF

If the STORE and WRITE pushbuttons are depressed together the memory function of the c.r.t. is switched off.

The instrument functions in the STORE mode in the event of a faulty pushbutton combination being selected.

PERSISTENCE/VIEW TIME

In the WRITE mode, this control enables a variable retention period for the recorded waveform (variable persistence).
The MAX position gives an increase of the writing speed by a factor of approx. 10 times; in this position the c.r.t. shows some background illumination. In the FAST mode, automatic erasure followed by the recording of a new picture occurs after a certain time. This time is determined by the position of the VIEW TIME knob.
In the MAX position of this knob, recording of a new picture occurs only after the ERASE button has been depressed. In this position the c.r.t. shows some background illumination.

VAR/MAX WRITING SPEED
(S27, R20, rear panel)

Switch S27 allows selection between maximum writing speed with background illumination or lower writing speed with less background illumination (adjustable with screwdriver control R20).

FOCUS

Continuously variable control of the c.r.t. electron beam focusing in the horizontal direction.
The vertical focusing is influenced by the INTENSity control. Therefore, the vertical focusing remains well-adjusted over nearly the whole INTENSity range.
For the extreme positions of the INTENS control, the vertical focusing potentiometer is adjustable via a ventilation hole in the left-hand side of the instrument.
The highest writing speed in the FAST mode is only obtained for optimum focusing of the electron beam.

TRACE ROT (R15);

Preset control for aligning the trace with the graticule line. Screw driver control on left-hand side of the instrument.

3 3.6. Miscellaneous

CAL (X1, X2)

Output socket providing a 2 kHz square-wave voltage of 3 Vp-p and a current of 6 mA for calibration purposes

⏚ (X5)

Measuring earth socket.

Z-MOD (X8) at rear side

Input socket for external Z-modulation.

3.4 PRELIMINARY SETTINGS

As the following settings are identical for both vertical channels, only the procedure for channel A has been indicated.
Unless otherwise stated, the controls occupy the same position as in the previous adjusting procedure.

3.4.1. Adjusting the gain

- Operate push-button A of the display-mode controls (S1)
- Operate push-button A of the trigger-mode selector switch (S22)
- Operate push-button AUTO of the trigger-mode controls (S8)
- Operate push-button MAIN TB of the horizontal deflection controls (S2)
- Display the trace by means of the A POSITION control
- Set the INTENSity and FOCUS controls for a sharp, well-defined trace
  The controls not mentioned may occupy any position.
- Set the channel A AC-0-DC switch to DC
- Set the channel A AMPLitude switch to 0.5 V and the continuous control to CALibrated
- Connect the CALibration socket to the A input socket.
- Check that the trace height is exactly 6 divisions.
  If necessary, readjust the GAIN control on the front panel, immediately below the AMPLitude switch.

3.5. INPUTS A AND B AND THEIR POSSIBILITIES

The oscilloscope has been provided with two identical channels, each of which can be used for either YT measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

3.5.1. YT measurements

To display one signal, one of the two vertical channels can be selected by operating either push-button A or push-button B of the vertical display-mode controls.
When push-button ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually. When the ALT button is operated, the display is switched over from one channel to the other at the flyback of the time-base signal. Although the ALTERNATE mode can be used at all sweep speeds of the time-base generator, the CHOPPED mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals is clearly visible to the eye.

In the CHOPPED mode, the display is switched over from one channel to the other at a fixed frequency.
If push-button ADD of the display mode switch is operated, the signal voltages of both vertical channels are added. Depending on the positions of the polarity switches, either the sum or the difference of the input signals is displayed. The ADDED mode also enables differential measurements. With these measurements advantage is taken from the common mode rejection in the ADDED position. When the polarity switches of both channels are set to opposite positions, the common mode parts of the signals on sockets A and B will undergo a very slight amplification only, with respect to the differential mode parts.

3.5.2. XY measurements

If push-button EXT X DEFL of the horizontal display-mode selection controls and one of the TRIG OR X DEFL controls are operated, the time-base generator are switched off. If for example push button A of S22 is depressed, a signal applied to the vertical A channel is then used for horizontal deflection. The AC/0/DC switch and the step attenuator of channel A remain operative. Horizontal trace shift is possible with the X POSITION control and continuous control of the deflection coefficients with the A AMPL/DIV control.
Vertical channel B may also be used for X deflection.
To this end, the B button of the TRIG OR X DEFL controls is depressed.

It is also possible to use an internal voltage at the mains frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after depressing the relevant push-button of the TRIG OR X DEFL controls. In the EXT and EXT ÷ 10 modes the trace width can be controlled with the X-AMPL/HOLD OFF potentiometer.
With this potentiometer in its CAL position, the deflection coefficient for external signals is 50 mV/DIV.
The external signal can be either d.c. or a.c. coupled (lower frequency limit 7 Hz) by depressing either the DC or the LF push-button of the trigger coupling controls of the main time-base.

3.5.3. AC/0/DC switch

The signals under observation are fed to input socket(s) A and/or B and the AC/0/DC switch is set to either AC or DC, depending upon the composition of the signal. As the vertical amplifier is d.c. coupled, the full band-width of the instrument is available and d.c. components are displayed as trace shifts in the DC position of the AC/0/DC switch.
This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. and l.f. signals. Some pulse drop will occur when l.f. square wave signals are displayed.

The 0 position interrupts the signal and earths the amplifier input for quickly determining the 0 V level.

3.6. TRIGGERING

If a signal must be displayed, the horizontal deflection must always be started on one fixed point of the signal in order to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from one of the vertical input signals, an internal voltage at mains frequency or an external source.

3.6.1. Trigger coupling

Three different trigger-coupling methods can be chosen with the DC/LF/HF switch. In the HF and LF positions, the transfer characteristic is limited.
In position DC the trigger signal is passed unchanged.
In position LF, a 0 Hz (7 Hz for external triggering) to 30 kHz band-pass filter is inserted. This position can be used to reduce interference from noise.
In position HF, a 30 kHz high-pass filter is inserted.
This position can be used to reduce interference from e.g. hum.

3.6.2. Selecting the trigger source and setting the trigger level

The trigger signal is obtained from channel A (button A depressed), channel B (button B depressed), the COMPosite A and B signals (buttons A and B simultaneously depressed), an external source (button EXT or EXT ÷ 10 depressed) or from an internal voltage at mains frequency (button EXT and EXT ÷ 10 depressed).
The trigger pulse shaper is a dual controlled multivibrator switched by the output signals of a differential amplifier.
The trigger signal, together with biasing voltages which are adjustable with the LEVEL potentiometer, fed to the inputs of the differential amplifier.
Depending on the LEVEL setting, a certain part of the trigger signal will be amplified by the differential amplifier.
The multivibrator is thus switched at a fixed point of the trigger signal (see Fig. 2.4.). This means that, with the aid of the LEVEL control, it is possible to scan the shape of the trigger signal (in case of internal triggering A or B equal to the shape of the signal to be displayed) and, thus, to choose the point where the multivibrator will be switched.
The LEVEL potentiometer is fitted with a push-pull switch which allows selection of the trigger slope.

3.6.3. Automatic triggering

When the AUTOmatic button of the AUTO-TRIG-SINGLE switch is operated, and if there are no trigger pulses available, the time-base generator is automatically free-running.
The trace is, therefore, always visible. The AUTOmatic mode can be used in all cases where also the TRIG mode is usable, except with signal frequencies lower than 10 Hz or pulse trains with an off time exceeding 100 ms.
As soon as trigger pulses are available, the free-running state of the time-base generator is automatically terminated and the time-base generator is triggered again as described in sections 2.2.4.1. and 2.2.4.2.
When the TRIGgered or SINGLE button is operated, the auto-circuit is switched off. The LEVEL setting can also be used in the AUTOmatic mode.

3.6.4. SINGLE sweep triggering

When effects which occur only once have to be observed (usually photographed), it is often desirable to ensure that only one sawtooth is generated, even though several trigger pulses might be produced after the phenomenon of interest. Of course, the single sawtooth in question must be triggered by a trigger pulse. To this end, the SINGLE button must be pressed. The first trigger pulse that appears after the button has been

released will start the time-base generator.
The time-base generator is then blocked until the SINGLE button is pressed again. The NOT TRIG'D lamp will light up as soon as the SINGLE button is depressed and remains lighting until the trigger pulse arrives.

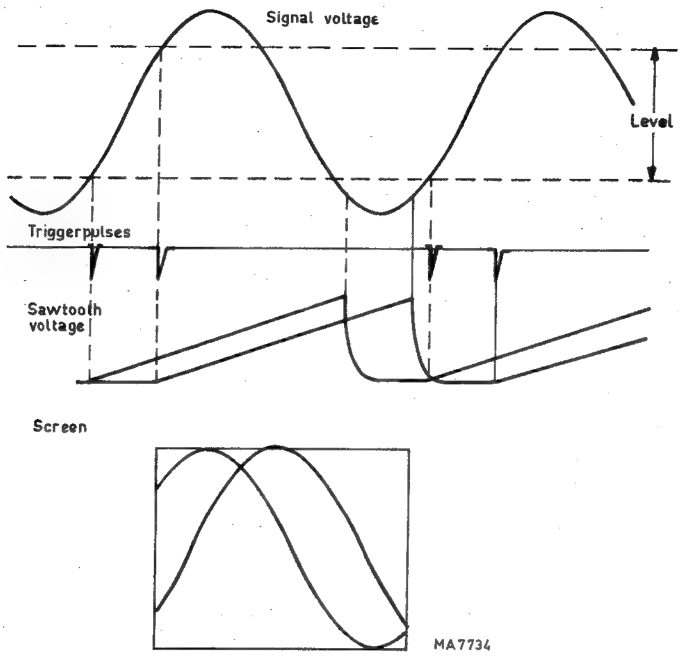


Fig. 3.2. Scanning the waveform by means of the LEVEL potentiometer

3.7. TIME-BASE MAGNIFIER (R2/S3)

The time-base magnifier is operated by a push-pull switch incorporated in the horizontal-POSITION control If this switch is pulled to position x10, the sweep speed of the main time-base generator is increased by a factor of 10. Thus, the portion of the signal displayed over a width equal to one division in the centre of the screen in the x1 position (TB MAGNifier depressed), will occupy the full width of the screen in the x10 position.
Any portion of the trace can be brought on to the screen by the horizontal-POSITION control for scrutinisation. In the x10 position, the time coeffcient is determined by dividing the indicated TIME/DIV value by 10.

3.8. USE OF THE DELAYED TIME-BASE

The delayed time-base can be used for the accurate study of complex signals. When push-button MAIN TB of the delayed t.b. trigger-source controls (S21) is operated, immediately the delayed time-base is on (i.e. the TIME/DIV switch is not at OFF), a portion of the displayed signal is intensified in the MAIN TB position of the horizontal deflection controls (S2). The DELAY TIME control (R1) enables this intensified portion to be shifted along the time axis. The duration of the intensified portion, its length, can be controlled in steps and continuously by means of the TIME/DIV controls of the delayed time-base generator. When push-button DEL'D TB of the horizontal deflection controls (S2) is operated, the intensified portion occupies the full width of the screen. In the DEL'D TB position, the delay time, (i.e. the interval between the starting point of the main time-base and the starting point of the delayed time-base) is determined by the settings of the main TIME/DIV controls and the DELAY TIME control.

If one of the other del'd t.b. trigger-source controls (S21) is operated, the delayed time-base is started by the first trigger pulse that occurs after the selected delay time. This trigger pulse is supplied by the trigger unit of the delayed time-base generator. This position is used when time jitter would otherwise give a blurred image of the detail under observation. This time jitter could be part of the signal being investigated or, at extreme magnification, originate in the time-base circuits.

3.9. USE OF THE ALTERNATE TIME-BASE (S2)

The PM 3266 is equipped with display switching. This offers the instrument user a simultaneous display of the signal on the two time scales provided by the main time-base and by the delayed time-base.
Detailed examination of a certain portion of the main time-base display is enabled by expanding the time interval of interest by means of the delayed time-base. Expansion is achieved by selecting a correspondingly faster sweep for the delayed time-base TIME/div. control. Positioning of the time interval is set by the DELAY TIME potentiometer.

The part of the signal under detailed observation by the delayed time-base remains as an intensified portion of the main time-base display. This not only facilitates the location of the required detail during dialling but also serves as a visual indication of which portion of the overall trace is being examined. One can immediately correlate the detail with the overall signal, which may be extremely complex, without the necessity of switching between MAIN TB and DEL'D TB.

Vertical shift between the two time-base displays is continuously variable with the TRACE SEParation control (R6).

3.10. USE OF THE 3RD CHANNEL TRIGGER VIEW

3.10.1. External or Internal triggering

In many applications such as triggering with digital signals or signals of widely differing forms, it is necessary to use an external trigger source to ensure proper timing relationships and to know the time relationship of the trigger signal and the measuring signal(s). By depressing the TRIG VIEW push-button, the external trigger signal (fed to input socket X7) is displayed as a third channel with the threshold near the horizontal central graticule line. By adjusting the LEVEL/SLOPE (R7, S7) control, it is easy to determine which part of the trigger signal is initiating the sweep. This is also possible for signals internally derived from the A or B channel when push-button A or B of switch S22 is depressed.

The sensitivity control of the external trigger view mode has two steps, 50 mV/div and 0,5 V/div.
With the push-button switch EXT (S22) depressed the deflection factor is 100 mV/div which is compatible with ECL levels.
In the mode EXT ÷ 10 (S22) the deflection factor is 1 V/div which is compatible with TTL levels.

3.10.2. Single shot

With control LEVEL/SLOPE (R7, S7) the trigger level can be set at a predetermined value without the need of an input signal. This is of importance when the signal to be measured is not available in advance as when single events are under test. When input signals, which surpass a known threshold, have to be displayed, the trigger level (R7, S7) can be set in advance and an input signal of sufficient amplitude will initiate the time-base sweep.

The procedure to set the trigger level is as follows: Depress push-button TRIG VIEW.
Position the trace by means of the LEVEL (R7) control so many divisions in opposite direction (in relation to the horizontal central graticule line) as the trigger threshold is required.

Note: The trigger threshold is defined as the distance between the triggerpoint and the zero line of the amplifier (i.e. without input signals and deflection by means of POSITION controls).

3.11. OPERATION OF THE STORAGE FUNCTIONS

MEMORY OFF mode

If the STORE and WRITE buttons are depressed the storage function is switched off and the instrument functions as a normal oscilloscope. In this mode, the INTENS knob controls the brightness of the displayed waveform. The FOCUS knob is used to obtain maximum sharpness of the display.

Blocking the memory system. If the instrument is waiting in the FAST mode (after the ERASE cycle has ended) for the time-base sweep, the instrument can only be put in the MEMORY OFF mode and not in the WRITE or STORE mode. The instrument can be put in the WRITE or STORE mode if the complete erase/write cycle of the FAST mode has been completed: in other words, only after the time-base has run and the image transfer has occurred.

WARNING: In the MEMORY OFF position, especially in the EXT X DEFL mode, excessive intensity for a prolonged period may damage the c.r.t.

WRITE mode

The waveform is recorded with normal writing speed. The position of the INTENS control determines the intensity of the waveform that is written on the storage layer of the c.r.t. Depending on the position of the PERSISTENCE control, a rapidly vanishing picture will be written on a green background (control entirely counter-clockwise) or a slowly vanishing trace on a black background (control adjacent to its first clockwise stop). The PERSISTENCE can be set to suppress any flickering when displaying a low frequency signal.

For a signal with a low repetition rate and a short rise-time the PERSISTENCE can be set so up to fill up the trace in order to obtain a clear and steady display.

The writing speed can be increased by a factor of approximately 10 by putting the PERSISTENCE control in the MAX position.

FAST mode

The waveform is recorded with high writing speed. The position of the INTENS control determines the intensity of the waveform that is written on the storage layer of the c.r.t. This mode is a single shot mode. If the VIEW TIME control is out of the MAX position the following cycle is repetitively performed. The stored picture is ereased and after that another picture is written when the time-base is triggered. After an adjustable viewing time the following cycle starts with the erasure of the c.r.t. screen. The viewing time is adjustable with the VIEW TIME control between 3 seconds (control entirely counter-clockwise) and 8 seconds (control adjacent to its first clockwise stop).

If the VIEW TIME knob is switched to the MAX position, recording of a new picture only occurs after the ERASE button has been depressed. In this mode it is also possible to transfer the instrument to the STORE mode after the time-base has run and a new picture is written.

For this function proceed as follows: put the instrument in the FAST mode and ERASE the picture. After this, the instrument will wait for a trigger signal. Now depress the STORE pushbutton and the instrument will transfer to the STORE mode after the new picture is written. To obtain a good quality picture, the waiting period for the trigger signal must not exceed one minute.

Due to the image-transfer process the fast mode is less suitable for low time-base sweep speeds. At these low sweep speeds the end of the trace will be more brilliant than the beginning of it.

STORE mode

This mode enables storage of a recorded waveform for a longer time than is available on the PERSISTENCE control. The INTENS control is operative: with the control adjacent to its first counter-clockwise stop, a long storage time of approximately one hour is available.
The waveform is not visible in this position.
With the INTENS control turned entirely clockwise the storage time is short: for figures see the section 'Characteristics'. Here, the waveform is clearly visible. The ERASE pushbutton is not operative in the STORE mode.

ERASE FACILITY

When the trace is no longer required it can be erased by pushing the ERASE button (not operative in the STORE mode). Occasionally, the trace may not entirely disappear, especially those parts which were written with substantial brightness.
The remaining trace can be removed by prolonged actuation of the ERASE button.

4. PERFORMANCE CHECK

4.1. GENERAL INFORMATION

This check is intended to check the oscilloscope's main functions with a minimum of test steps and actions required. It is assumed that the operator doing this test is familiar with the oscilloscope and its characteristics.

WARNING:	Before switching on, ensure that the oscilloscope has been installed in accordance with the instructions mentioned in chapter 2.

If this test is started a few minutes after switching on, bear in mind that test steps may be out of specification, due to insufficient warming-up time.
To be sure that this will not happen, allow the full indicated warming-up time. The test should be done at an environmental temperature of 20 ... 30^{o}C.
The measuring values that must be checked are indicated without tolerance and represent the characteristics of an average instrument: for tolerances see chapter 1.2. "Characteristics". The checks are carried out with the use of the instrument's internal calibration voltage generator.

WARNING:	Use the minimum necessary beam intensity to produce a clear, well-defined display. Extended high intensity may damage the memory system of the cathode ray tube.

4.2. STARTING POSITIONS OF THE CONTROLS

- Select MEMORY OFF mode: depress pushbuttons STORE and WRITE of the memory mode selector S24.
- Depress pushbutton AUTO of trigger mode selector S8.
- Depress pushbutton ALT of the vertical display mode selector S1.
- Put the channel A and B AMPL/DIV switches S9 and S11 in the 0,5 V/DIV position and their verniers R8/S10 and R9/S12 in the CAL position.
- Put the channel A and B POSITION controls R3/S4 and R4/S5 in their mid position and depress them.
- Put the channel A and B AC/0/DC signal coupling controls S17 and S18 in the 0-position.
- Put the main time-base TIME/DIV switch S15 in the 0,1ms/DIV postition and its vernier control R11/S16 in the CAL position.
- Put the delayed time-base TIME/DIV control S13 in the OFF position and its vernier control R10/S14 in the CAL position.
- Depress pushbutton MAIN TB of the horizontal display mode selector S2.
- Put the horizontal POSITION control R2 in its mid position and depress it.
- Depress the DC pushbuttons of the MAIN TB and DEL'D TB trigger coupling switches S19 and S20.

4.3. C.R.T. DISPLAY SECTION

- Adjust the INTENS and FOCUS controls R14 and R17 for a well-defined display. When carrying out these checks it may be necessary to readjust the controls.
- Centre the channel A and B time-base lines using the POSITION position potentiometers R3, R4 and R2.
- Check if the time-base lines run exactly in parallel with the horizontal graticule lines. If not readjust the TRACE ROTATION control R15. This screw driver operated control is attainable via a ventilation hole in the left side panel of the instrument.

4.4. VERTICAL CHANNELS

- The checking of channel A and B is identical. The knobs, sockets and adjusting elements of channel B are shown in brackets behind those of channel A.
- Put the main time-base TIME/DIV switch in the 50 ms/DIV position and check if channel A and B are alternately displayed.
- Depress pushbutton CHOP of the vertical display mode selector and check that it looks like channel A and B are displayed simultaneously.
- Put the main time-base TIME/DIV switch in the 0,1 ms/DIV position.
- Depress pushbutton A (B) of the vertical display mode selector: now only the channel A (B) time-base line is visible.
- Depress pushbutton A (B) of the main time-base trigger source selector S22.
- Apply the output voltage from the CAL socket X1/X2 to the channel A (B) input socket X3 (X4).
- Put the channel A (B) signal coupling switch in the DC-position: the output signal from the CAL socket now becomes visible on the screen.
- Adjust the main time-base LEVEL so that a stable waveform is written. The vertical deflection must be 6 divisions. If not readjust screw driver operated front panel adjustment point R12 (R13).
- Also check the trigger SLOPE selection S7 that is incorporated in LEVEL control R7. If the control R7/S7 is pulled the trace starts at negative going slope of the signal and if it is depressed the trace starts at the positive going slope of the signal.
- The signal that is displayed now is a square-wave with a bottom level of 0 Volt and a top level of 3 Volt. The signal contains a DC component of 1,5 Volt. With the AC/0/DC coupling switch in the AC position the DC component is blocked and the signal now is situated symmetrical around the 0 Volt level on the screen. Now check the AC position.
- Check if the channel A (B) signal on the screen is inverted if the PULL TO INVERT function is switched on by pulling the A (B) POSITION control S4/R3 (S5/R4).
- Depress the channel A (B) POSITION control again.

- Depress pushbutton EXT X DEFL of the horizontal deflection mode selector.
- Depress the A (B) pushbutton of the main time-base trigger source selector.
- Apply the output voltage of the CAL socket to the channel A (B) input socket.
- Depress the B (A) pushbutton of the vertical deflection mode selector.
- Check that two points are displayed that have a horizontal distance of 6 divisions.

- Depress pushbutton TRIG VIEW of the vertical deflection mode selector.
- Depress pushbutton A (B) of the main time-base trigger source selector.
- Apply the output voltage of the CAL socket to the channel A (B) input socket.
- Depress pushbutton MAIN TB of the horizontal deflection mode selector.
- Check that a square-wave signal of 6 divisions is displayed on the screen. This signal is shifted a vertical sense if the main time-base LEVEL control is operated.

4.5. TIME BASES AND TRIGGERING

- Depress pushbutton A (B) of the vertical display mode selector.
- Apply the output signal of the CAL socket to the channel A (B) input socket.
- Depress pushbutton A (B) of the main time-base trigger source selector.
- Put the main time-base TIME/DIV switch is the 0,1ms/DIV position.
- Depress pushbutton MAIN TB of the horizontal display mode selector.
- Adjust the main time-base LEVEL control for a triggered display.
- Pull the TB MAGN knob R2/S? that is incorporated in the horizontal POSITION control and check that the horizontal deflection is m gnified by a factor of ten times.
- Depress the TB MAGN knob again.
- Depress the SINGLE pushbutton of the trigger mode selector S8. Check if the main time-base runs only once after release of this pushbutton.
- Depress the AUTO pushbutton of the trigger mode selector again.

- Put the delayed time-base TIME/DIV control S13 in the 20μs/DIV position and its vernier R10/S14 in the CAL position.
- Depress pushbutton MAIN TB of the delayed time base trigger source selector S21.
- Check that an intensified part becomes visible on the main time-base signal and that this part can be shifted along the main time-base line by means of the DELAY TIME control R1.
  If necessary readjust the INTENS control for a better intensity ratio between the main time-base signal and the intensified part.

- Depress pushbutton DELD TB of the horizontal display mode selector and check if the intensified part now covers the entire horizontal screen width.
- Depress pushbutton ALT TB of the horizontal display mode selector. Now both the main time-base signal with intensified part and the intensified part displayed over the entire horizontal screen width must be displayed. The vertical shift between both displays must be adjustable by means of the TRACE SEParation control R6.

- Depress pushbutton MAIN TB of the horizontal display mode selector.
- Depress pushbutton A (B) of the delayed time-base trigger source selector.
- Adjust the delayed time-base LEVEL control R5 in such a way that the intensified part is visible on the main time-base signal. Check also the trigger SLOPE function S6 that is incorporated in the LEVEL control.

4.6. MEMORY FUNCTIONS

- Depress pushbutton A of the vertical display mode selector.
- Apply the output voltage of the CAL socket to the channel A input socket.
- Put the delayed time-base TIME/DIV switch in the OFF position.
- Depress pushbutton A on the main time-base trigger source selector.
- Depress pushbutton MAIN TB on the horizontal deflection selector S2.
- Adjust the main time-base LEVEL control in order to obtain a triggered display on the screen.
- Depress the SINGLE pushbutton of the trigger mode selector.

- Put the PERSISTENCE control R16/S26 fully counter clockwise.
- Depress the WRITE pushbutton of the memory mode selector S24: the screen now shows a green background illumination.
- If the ERASE pushbutton S25 is operated a waveform is written in; the persistence time of this waveform must increase if the PERSISTENCE control is moved in clockwise direction towards its first stop. At the same time the background illumination must decrease.
- Put the PERSISTENCE control in the MAX position: some background illumination must become visible now.
- Write a waveform in and depress pushbutton STORE of the memory mode selector. Check if in this mode the brightness of the waveform is adjustable by means of the INTENS control.

- Depress pushbutton FAST of the memory mode selector and check if a waveform can be written in. A waveform is written in after operation of the ERASE pushbutton if the VIEW TIME control R16/S26 occupies the MAX position.
- More the VIEW TIME control out of the MAX position. The erasure and write in cycle is initiated automatically now with an adjustbale interval between the cycles: the interval must be short with the VIEW TIME control fully counter clockwise and must increase if the control is moved in clockwise direction towards its first stop.

5. PREVENTIVE MAINTENANCE

5.1. GENERAL INFORMATION

This instrument generally requires no maintenance, as the instrument contains no components that are subject to wear.
However, to ensure reliable and troublefree operation, the instrument should not be exposed to moisture, heat, corrosive elements or excessive dust.

5.2. CLEANING THE NEXTEL SUEDE COATING

WARNING: The Nextel suède coating is ethanol-resistant, but is susceptible to methylated spirit, which will attack the surface (due to one of the de-naturing substances).

The bright appearance of the cabinet, lacquered with Nextel suède coating will deteriorate after some time as the surface becomes soiled. Cleaning with a cloth soaked in water, ethanol or a common household cleansing agent does not always restore this lustre and leaves dirt in the holes and the pores.

The 3M Company have developed a new cleansing pad (White Cleansing Pad, Catalogue No. 8440) which when soaked in water, ethanol or a common household cleansing agent will also penetrate holes and pores.

This method is similar to that of abrasive cleaning pads but lacks their abrasive action.
Abrasive cleaning pads should not be used, otherwise surface scratches will result.

5.3. RECALIBRATION

From experience it is expected that the oscilloscope operates within its specification for a period of at least 1000 hours or for six months if used infrequently.
In addition, replacement of components may necessitate recalibration of the affected circuits. The checking & adjusting procedure can also be helpful in localising certain troubles in the instrument.
In some cases, minor troubles may be revealed and/or corrected by recalibration. Complete checking & adjusting instructions are given in the Checking & Adjusting Section.

Gebrauchsanleitung

1. ALLGEMEINES

1.1. EINLEITUNG

PM 3266 ist ein tragbares Speicher-Oszilloskop mit sehr hoher Schreibgeschwindigkeit (1000 Teil/μs). Das Gerät ermöglicht die Messung von Signalen bei sehr hoher Empfindlichkeit (2 mV/Teil) über eine grosse Bandbreite (100 MHz). Das Oszilloskop ist mit vielen integrierten Schaltungen bestückt wodurch sehr stabiler Betrieb gewährleistet ist und die Zahl der Einstellorgane verringert wird. Zur Erleichterung von Prüfung und Einstellung sind an geeigneten Stellen rund um die Schaltung Messpunkte vorgesehen. Das Gerät besitzt verschiedene Speicherfunktionen wie Normal- und Eilschreibgeschwindigkeit und automatische Löschung.

Die grosse Auswahl von Darstellungsmöglichkeiten umfasst: Darstellung eines Kanals, zwei Kanäle alternierend oder gechopped; zwei Kanäle addiert mit normaler und invertierter Lage für beide Eingangssignale sowie eine Hauptzeitbasis und eine verzögerte Zeitbasis.

Zusätzliche Besonderheiten des PM 3266 sind der dritte Kanal TRIG VIEW und die ALTernate TB (alternierende Zeitbasis) Möglichkeit.

TRIG VIEW gestattet Darstellung des Triggersignals (intern oder extern angelegt) über einen dritten Kanal durch Drucktastenwahl).

ALT.TB bietet dem Gebraucher eine gleichzeitige Darstellung des Signals auf den beiden von Hauptzeitbais und verzögerter Zeitbasis gelieferten Zeitmassstäben.

Das Oszilloskop PM 3266 hat eine Speisung mit niedriger Verlustleistung und lässt sich mittels eines Umschalters auf zwei Spannungsbereiche, nämlich 100 V bis 127 V und 220 V bis 240 V einstellen. Dadurch erübrigt sich innerhalb dieser beiden Bereiche die dauernde Einstellung auf die örtliche Netzspannung.

Durch alle diese Eigenschaften eignet sich das Oszilloskop für einen ausgebreiteten Einsatzbereich.

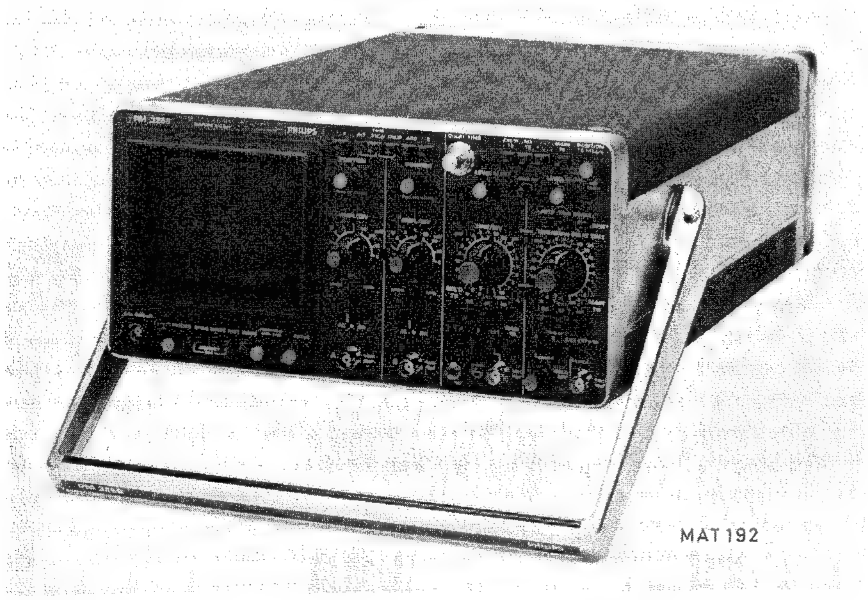


Abb. 1.1. Tragbares Zweistrahl-Speicher oszilloskop PM 3266

1.2. TECHNISCHE DATEN

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für Mess- und Regeleinrichtungen, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in verliegender Anleitung enthalten sind.

- Diese Kenndaten gelten nach einer Anwärmzeit des Geräts von 30 Minuten (Bezugstemperatur 23°C).
- Zahlenwerte mit Toleranzangaben werden vom Hersteller garantiert.
  Zahlenwerte ohne Toleranzangaben sind Durchschnittswerte und dienen nur zur Information.
- Ungenauigkeiten (absolut oder in %) sind bezogen auf den angegebenen Bezugswert.

1.2.1. Bildteil

Benennung	Beschreibung	Näher Angaben
Elektronenstrahlröhre	Philips L14-140GH/95	Speicherröhre mit hoher Schreibgeschwindigkeit, Bildübertragung und Vergrösserung der vertikalen Ablenkempfindlichkeit, mittels eines elektronischen Linsensystem (scan magnification) Rechteckiger Schirm, Nachbeschleuniger und metallhinterlegter Leuchtschirm.
Ausnutzbare Schirmfläche	8 x 10 Teile	1 Teil = 0.9 cm. Vertikale und horizontale Linien müssen gerade sein im Zentralen 7 x 9 DIV Schirmgebiet.
Schirmtyp	P31 (GH) Phosphor	
Gesamte Beschleunigungsspannung	10 kV	
Raster	Intern	Nicht beleuchtet
Einteilung	Gestrichelte Linien bei 1,5 und 6,5 Teil vom oberen Bildschirm dienen als Messraste zur Prüfung der Anstiegszeit	
Schreibgeschwindigkeit	1000 Teil/μs	Bei Betriebsart FAST. Nicht garantiert für das Quadrat 2 x 2 Teil in jeder Schirmecke.
	2,5 Teil/μs	Bei Betriebsart Write und Stellung MAX
	0.25 Teil/μs	Bei Betriebsart WRITE
Speicherzeit	1 Stunde max.	Betriebsart STORE: Abhängig von der Stellung von Knopf INTENS (Helligkeit)
	60 Sek.	Bei Betriebsart WRITE (maximale Helligkeit)
	15 Sek.	Bei Betriebsarten MAX WRITE und FAST (maximale Helligkeit)
Nachleuchtdauer	0,3 S. . . 1 min.	Wirksam bei Betriebsart WRITE Stufenlos einstellbar

Automatische Löschung	Wirksam bei Betriebsart FAST mit VIEW TIME aus Stellung Max. Betrachtungszeit zwischen 3 s und 8 s stufenlos einstellbar.	Beim automatischen Löschbetrieb wird folgender Zyklus ausgeführt: Das Bild wird gelöscht. Wenn die Zeitbasis getriggert ist, wird ein neues Bild geschrieben. Nach der eingestellten Signal darstellungszeit beginnt der neue Zyklus und das Bild wird gelöscht u.s.w. Bei Betriebsart FAST sind die Drucktasten AUTO, TRIG und SINGLE nicht wirksam. Ihre Funktion wird von der Speichereinheit übernommen.
Löschzeit	1,3 s bei Betriebsart WRITE, 1,6 s bei Betriebsart FAST	Die angegeben Werte stellen die Zeit dar, die zwischen Auslösung der Taste ERASE und dem Ende des Löschzyklus verstreicht. Mit Taste ERASE erfolgt die Rückstellung der Hauptzeitbasis.
Ausrichtung der Leuchtspur (TRACE ROTATION)	Schraubenziehereinstellung	Ist über eines der Belüftungslöcher an der Linken Seite das Geräts zugänglich

1.2.2. Vertikale oder Y-Achse

1.2.2.1. Kennlinie (2 mV Bereich ausgenommen)

Frequenzbereich	DC ... 100 MHz AC 7 Hz ... 100 MHz	–3 dB, Gleichspannungskopplung –3 dB, Wechselspannungskopplung Der Frequenzbereich beinhaltet einen 10:1 Messkopf über 20-30 °C.
Anstiegzeit	3.5 ns	Siehe Abb. 1.5.
Überschwingen	± 4 % Spitze-Spitze	Über 6 Teile, +5-+40 °C

1.2.2.2. Ablenkkoeffizient

		(für Kenndaten des 2 mV Bereichs siehe 1.2.2.13.).
	2 mV/Teil ... 5 V/Teil	Elf kalibrierte Stellungen, Folge 1-2-5. Nicht kalibriert stufenlos einstellbar 1:2,5 Nichtkalibriert Lampenanzeige.
Fehlergrenze	± 3 %	Ausgenommen Linearität der Elektronenstrahlröhre
Hochstzulässige Eingangsspannung	± 400 V 800 V_{SS}, Wechselspannung	Gleichspannung + Spitzenwert einer Wechselspannung. Minderung bei Frequenzen über 500 kHz. Siehe Abb. 1.2.
Maximale unverzerrte Ablenkung	24 Teile	Bis 35 MHz
Verschiebungsbereich	16 Teile	Je 8 Teile über und unter der mittleren Rasterlinie.

1.2.2.3. Eingangsimpedanz

Eingangsimpedanz	1MΩ (± 2%) //≈ 15pF	
Zeitkonstante der Eingangsschaltung	22 ms	Kopplungsschalter auf AC

	Benennung	Beschreibung	Nähere Angaben
1.2.2.4.	*Instabilität*		(2 mV/Teil Einstellung siehe 1.2.2.13.).
	Instabilität des Leuchtflecks	0.1 Teil/Stunde	Temperaturbereich 20 - 40 °C.
	Bildsprung	0,2 Teil	Beim Schalten zwischen einer der Stellungen des Abschwächers
	Bildsprung	0,5 Teil	Beim Schalten des NORM/INVERT Schalters
	Bildverschiebung	0.2 Teil	Beim Drehen des kontinuierlichen Abschwächers. 0.4 Teil in 5 mV Stellung
	Bildverschiebung	1 Teil	Beim Eindrücken der Taste ADDED 0.4 Teil in 5 mV Stellung Ansteigend beim Drehen des stufenlosen Abschwächers.
1.2.2.5.	*Kurzzeit-Temperaturdrift*	Wie 1.2.2.6.	
1.2.2.6.	*Langzeit-Temperaturdrift*	20 μV/°C	Typischer Wert
1.2.2.7.	*Sichtbare Signalverzögerung*	Ca. 15 ns	
1.2.2.8.	*Darstellungsarten*	Kanal + oder –A allein Kanal + oder –B allein Darstellung des Triggersignals allein Kanäle ± A und ± B gechoppt Kanäle ± A und ± B alternierend Kanäle ± A und ± B addiert Triggersignalbild ± A und ± B gechoppt oder alternierend (3-Kanal Anzeige)	Wenn 3-Kanal Anzeige zusammen mit alternierender Zeitablenkdarstellung gewählt ist, erfolgt dies automatisch in aufgehellter Zeitablenkungsart. Siehe 1.2.2.12 für alle Kenndaten der Triggersignal-Darstellung.
1.2.2.9.	*Chopperfrequenz*	≈ 1 MHz	Anzeigedauer pro Kanal ca. 350 ns
1.2.2.10.	*Übersprechen zwischen Kanälen*	1:500	Bis 50 MHz. Mit acht Teilen der Signalamplitude auf einem Kanal. Übersprechen auf dem anderen Kanal innerhalb Zeitbasislinienbreite bis auf 35 Mc. Beide Abschwächer in gleicher Einstellung.
1.2.2.11.	*Gleichtaktunterdrückung*	Besser als 100 bis 2 MHz 20 bei 50 MHz	Gemessen bei +A und –B addiert. Max. Gleichtaktsignal 8 Teile

Benennung	*Beschreibung*	*Nähere Angaben*
1.2.2.12. Triggersignal Darstellung		
Anzeige	Externes oder internes Triggersignal	
Ablenkkoeffizient	Gleich an vertikal	
Extern	100 mV/Teil ± 3 %	
Extern ÷ 10	1 V/Teil ± 5 %	
Intern	Vertikal ± 10 %	
Triggerpunkt	Schirmmitte ± 0,3 Teil	Gleichspannungskopplung
Überschwingen	± 10 % Spitze-Spitze	
Verzögerungszeit zwischen Vertikaleingang und externem Eingang	3 ns ± 1 ns	
Bandbreite	80 MHz	Typischer Wert
1.2.2.13. Kenndaten für die 2 mV/Teil Einstellung		
a. Ablenkkoeffizient	2 mV/Teil	
Fehlergrenze	± 5 %	
b. Kennlinie		
Frequenzbereich	d.c. 0 ... 35 MHz a.c. 7 Hz ... 35 MHz	–3 dB –3 dB
Anstiegzeit	10 ns	
Überschwingen	± 5 % Spitze-Spitze	
Gleichtaktunterdrückung	Besser als 100 bis 2 MHz	
c. Instabilität		
Instabilität der Leuchtspur	0,25 Teil/Stunde	20-40 °C Temperaturbereich
Bildsprung	1 Teil	Beim Umschalten vom 5 mV auf 2 mV Abschwächerstellung
Bildsprung	2 Teile	Bei Betätigung des Schalters NORM/INVERT
Bildverschiebung	1 Teil	Beim Drehen des kontinuierlichen Abschwächers.
Bildverschiebung	1 Teil	Beim Schalten auf Stellung ADDED

1.2.3. Horizontale oder X-Achse

1.2.3.1. Darstellungsmöglichkeiten	– Hauptzeitablenkung – Hauptzeitablenkung aufgehellt durch verzögerte Zeitablenkung – Verzögerte Zeitablenkung	
	– Hauptzeitablenkung aufgehellt und verzögerte Zeitablenkung alternierend dargestellt	Leuchtspurentrennung von 4 Teilen möglich
	– X-Y und X-Y/Y Betrieb	X-Ablenkung durch: – Kanal A Signal – Kanal B Signal – Signal über EXT Anschluss der Hauptzeitablenkung – Netzspannung

	Benennung	*Beschreibung*	*Nähere Angaben*
1.2.3.2.	*Horizontaldrift in X1 Stellung*	0,2 Teil/Stunde	Die Horizontaldrift bei X1 Dehnung darf 0,1 Teil/Stunde über 20-40 ^{o}C Temperaturbereich nicht überschreiten. Die gleichen Stabilitätsbedingungen gelten für den Start der Ablenkung bei Änderungen der Ablenkgeschwindigkeitseinstellung, ausgenommen sind die höchsten Ablenkbereiche (50-100 ns/Teil)
1.2.3.3.	*Horizontalverschiebung*	± 5,2 Teile von Schirmmitte	Der Steller für die Horizontalverschiebung umfasst Grob- und Feineinstellung.
1.2.4.	**Hauptzeitablenkung**		
1.2.4.1.	*Betriebsart*	Getriggert Automatisch Einmalig	Automatischer Freilauf bei Abwesenheit von Triggersignalen nach weniger als 0,1 s.
1.2.4.2.	*Zeitmassstäbe*	1 s/Teil ... 50 ns/Teil	In 23 Kalibrierten Stufen, Folge 1-2-5 Dazwischen stufenlos einstellbar 1:2,5 nicht kalibriert. Eine Lampe UNCAL (nichtkaliebriert) für sowohl Hauptzeitablenkung wie verzögerte Zeitablenkung (MTB und DTB).
1.2.4.3.	*Fehlergrenze des Zeitmassstabes*	±2 % ±3 %	+20 ^{o}C ... +30 ^{o}C + 5 ^{o}C ... +40 ^{o}C
	Die Differenz in Ablenkgenauigkeit über beliebige 2 Teile		Die Differenz in Zeitablenkungs-Genauigkeit für 2 beliebige Teile von 10-Teil-Zeitablenkung ist ± 5%. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
1.2.4.4.	*Anzeigendehnung*		
	Dehnung	10x	Geschaltet, kalibiriert. Wenn das Bild mit der mittleren vertikalen Rasterlinie zusammenfällt darf es beim Ändern der horizontalen Dehnung von X10 auf X1 um nicht mehr als 1 Teil verschieben.
	Koeffizientfehler	± 1 % zusätzlich	± 5 % bei den ersten und letzten 50 ns von 5 ns/Teil, 10 ns/Teil und 20 ns/Teil der gedehnten Zeitablenkung.
	Kürzester Zeitmassstab	5 ns/Teil	
1.2.4.5.	*Regelbare Sperrzeit ("hold-off")*	Die Sperrzeit der Zeitablenkung kann bis zum Faktor 10 vergrössert werden.	
1.2.5.	**Verzögerte Zeitablenkung**		
1.2.5.1.	*Betriebsart*	Verzögerte Zeitablenkung startet nach Wahl, entweder sofort nach Ablauf der Verzögerungszeit oder nach Empfang des ersten Triggerimpulses nach Verstreichen der Verzögerungszeit.	

	Benennung	*Beschreibung*	*Nähere Angaben*
1.2.5.2.	*Langzeitstabilität des Komparators*	< 2 Teil bei 1000 mal Dehnung	Mit Hauptzeitablenkung bei 1 ms/Teil und verzögerte Zeitablenkung bei 1 µs darf eine gewählte Signaleinzelheit in verzögerter Zeitablenkungsart nach Anwärmzeit nicht mehr als zwei Teile bewegen.
1.2.5.3.	*Zeitmassstäbe*	0,5 s/Teil ... 50 ns/Teil	In 22 kalibrierten Stufen (Folge 1-2-5). Dazwischen stufenlos einstellbar 1:2,5 nicht kalibriert. Eine Lampe UNCAL (nichtkalibriert) für sowohl Hauptzeitablenkung wie verzögerte Zeitablenkung (MTB und DTB).
1.2.5.4.	*Fehlergrenze des Zeitmassstabes*	±2 % ±3 %	+20 $^{\circ}$C ... +30 $^{\circ}$C + 5 $^{\circ}$C ... +40 $^{\circ}$C Die Differenz in Zeitablenkungs-Genauigkeit für zwei beliebige Teile von 10-Teil-Zeitablenkung ist ± 5 %. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
1.2.5.5.	*Verzögerungszeit*	Stufenlos zwischen 0x und 10x der Zeitkoeffizient, der Hauptzeitablenkung	Kalibriert. Bereich des Verzögerungszeitvervielfachers 0,00-9.99 Inkrementale Genauigkeit 0,5 %, typisch 0,2 %.
1.2.5.6.	*Verzögerungszeitjitter*	1 : 20.000	
1.2.6.	**X-Ablenkung**		
	X-Ablenkung über Kanal Y_A oder Y_B	~~2 mV/Teil ... 5 V/Teil~~	~~Nichtkalibrierte stufenlose Einstellung~~ 1:2,5 über Potentiometer Y GAIN.
1.2.6.1.	*Koeffizientfehler*	± 5 %	
1.2.6.2.	*Bandbreite*	0 - 2 MHz	–3 dB Bandbreite über 4 Teile in horizontaler Schirmmitte bis zu 100 kHz
1.2.6.3.	*Maximale unverzerrte Ablenkung*	20 Teile	
1.2.6.4.	*Phasenverschiebung bezogen auf Y Darstellung*	3° bei 100 kHz	
	Externe X-Ablenkung über Buchse EXT		
1.2.6.5.	*Ablenkkoeffizient*		
	Ext Ext. ÷ 10	50 mV/Teil 500 mV/Teil	Nichtkalibrierte stufenlose Einstellung 1:3
1.2.6.6.	*Genauigkeit Ext.: 1*	± 3 %	Zusätzlich 2 % für Ext.: 10
1.2.6.7.	*Bandbreite*	d.c. ... 2 MHz 7 Hz ... 2 MHz	Über DC Triggerkopplung Über NF oder HF Triggerkopplung
1.2.6.8.	*Eingangscharakteristiken*	Gleiche Werte wie Y-Kanäle	
1.2.6.9.	*Phasenverschiebung bezogen auf Y-Kanäle*	3° bei 100 kHz	

Benennung	Beschreibung	Nähere Angaben
1.2.6.10. Linearität	1,5 %	
1.2.6.11. Drift	0,2 Teil/Stunde	
1.2.7. Triggerung der Hauptzeitablenkung		
1.2.7.1. Triggerquelle	Intern von Kanal A Intern von Kanal B Zusammengesetzt A und B Intern von Netz Extern Extern: 10	 Nur Betriebsart vertikal alternierend
1.2.7.2. Betriebsart	Automatische Triggerung	Automatischer Freilauf des Zeitablenkgenerators etwa 100 ms nach Verschwinden des Triggersignals.
	Normale Triggerung Einmaliger Ablauf der Zeitablenkung	Lampe NOT TRIG'D leuchtet nach Rückstellung und erlischt am Ende der Ablenkung.
1.2.7.3. Flanke	+ oder –	
1.2.7.4. Empfindlichkeit	Internal: 0,5 div bis 1,5 div bei 100 MHz.	Typischer Wert, frequenzabhängig Siehe Abb. 1.3.
	External: 50 mV bis 150 mV bei 100 MHz. External/10 : 500mV bis 1.5V bei 100MHz	Typischer Wert, frequenzabhängig Siehe Abb. 1.4.
1.2.7.5. Filterbandbreite	DC – ganze Bandbreite NF int.: 0 - 30 kHz NF ext.: 7 Hz - 30 kHz HF : 30 kHz - 100 MHz	Intern und extern –3 dB –3 dB –3 dB, intern und extern
1.2.7.6. Pegelbereich		
Interne Triggerung	24 Teile	
Externe Triggerung	+1,2 V bis –1,2 V	
Extern: 10	+12 V bis –12 V	
1.2.7.7. Eingangsimpedanz	1MΩ (± 2%)//≈ *15pF*	
1.2.7.8. Triggerjitter	Besser als 0,5 ns	
1.2.8. Triggerung der verzögerten Zeitablenkung		
1.2.8.1. Triggerquelle	Intern von Kanal A Intern von Kanal B Extern	Übrige Eigenschaften sind die gleichen wie bei TRIGGERUNG DER HAUPTZEITABLENKUNG, ausgenommen Ext÷10 und Netztriggerung
1.2.9. Kalibrierungseinheit		
1.2.9.1. Ausgangsspannung	3 V_{SS}	
1.2.9.2. Ausgangsstrom	6 mA	
1.2.9.3. Fehlergrenze	± 1 %	Spannung und Strom

	Benennung	Beschreibung	Nähere Anlage
1.2.9.4.	*Frequenz*	2 kHz ± 2 %	
1.2.9.5.	*Sicherung*	Der Ausgang ist gegen Dauerkurzschlüsse gesichert	

1.2.10. Eingänge/Ausgänge an Rückseite

1.2.10.1.Z-Achsensteuerung	Gleichspannungsgekoppelt TTL-Kompatibel Positive Polarität verstärkt das Bild. Ansprechzeit 35 ns. Eingangsimpedanz 10 kΩ Max. Eingangsspannung 50 V	
1.2.10.2.Torausgang der Hauptzeit ablenkung	0 ... +5 V geliefert während der Hauptzeitablenkung	Wahlweise erhältlich, Ausgangsimpedanz 1 KOhm.
1.2.10.3.Torausgang der verzögerten Zeitablenkung	0 ... +5 V geliefert während der verzögerten Ablenkung	Wahlweise erhältlich, Ausgangsimpedanz 1 KOhm

1.2.11. Speisung

1.2.11.1.Netzspannungen	Wechselspannung: 100 ... 127 V (± 10%) 220 ... 240 V (± 10%) Gleichspannung: 250 ... 350 V	Automatisch gegen falsche Einstellung des Netzwahlschalters geschützt.
1.2.11.2.Netzfrequenz	46 bis 440 Hz	
1.2.11.3 Leistungsaufnahme	50 W	
1.2.11.4.Sprunghafte Netzänderungen		Bei Auftreten von sprunghaften Spannungsänderungen kann der Oszillograf nicht beschädigt werden, entsprechend den MIL-T-28800 Bedingungen.

1.2.12. Einflussgrössen

Die angegeben Daten gelten nur dann, wenn das Gerät gemäss den offizielen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND angefordert werden.

1.2.12.1.Temperaturprüfungen

Nach Vorschriften IEC 68 Ab und Bb.
Arbeitsbereich: –15 °C ... +55 °C.
Betrieb innerhalb Spezifikation: +5 °C ... +40 °C. Ausgenommen die pro Spezifikation angegebenen Toleranzen.
Lagerung: –40°C bis +70°C. Geprüft von –55°C bis +75°C.

1.2.12.2.Höhe

Nach Vorschriften IEC 68-2-13, Test M
Arbeitshöhe: bis 5000 m
Minderung: 1 °C/300 m für die max. Arbeitstemp.
Lagerung: bis 17.000 m.

1.2.12.3. Stossfestigkeit

In Betrieb: 30 g, ½ Sinus, Dauer 11 ms, 2 Stösse pro Achse pro Richtung bei insgesamt 12 Stössen.

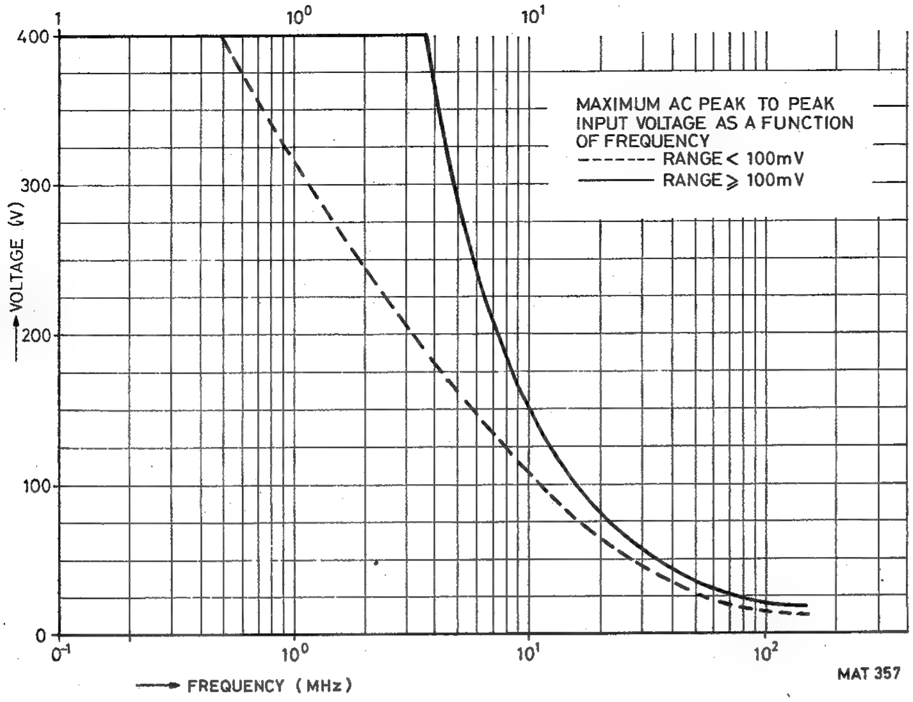


Abb. 1.2. Minderung der höchstzulässigen Eingangsspannung, frequenzabhängig.

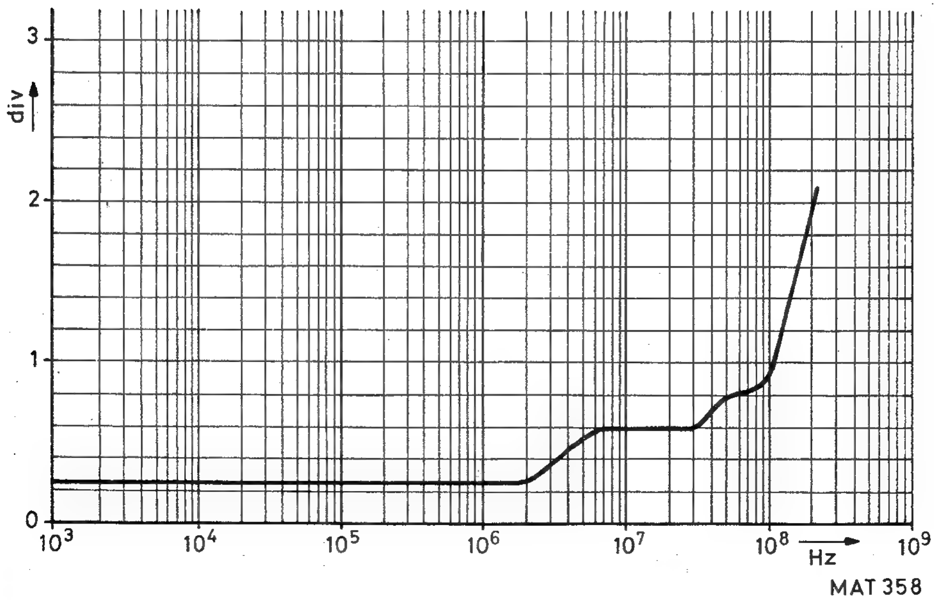


Abb. 1.3. Typische Ablenkempfindlichkeit für interne Triggerung, frequenzabhängig.

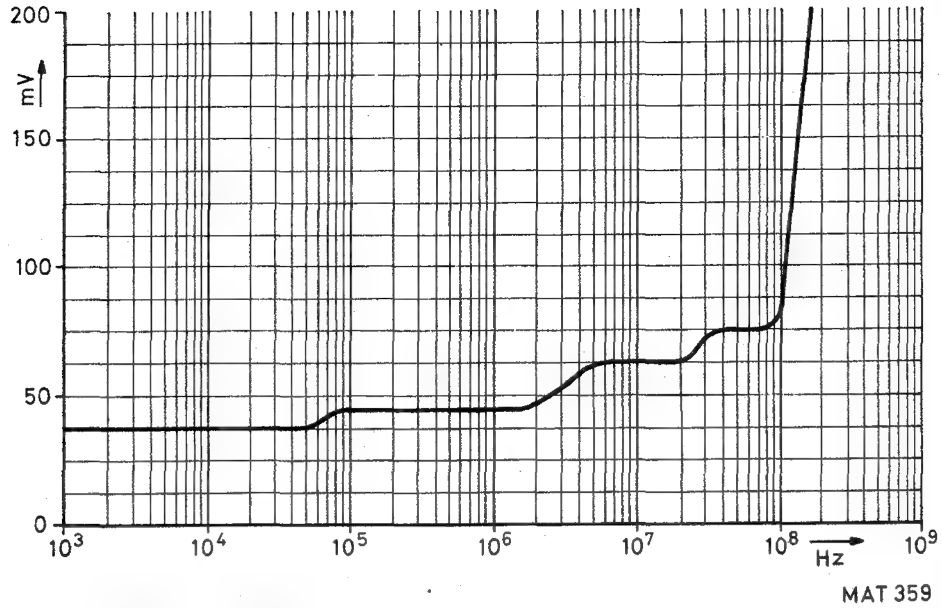


Abb. 1.4. Typische Ablenkempfindlichkeit für externe Trigerrung, frequenzabhängig.

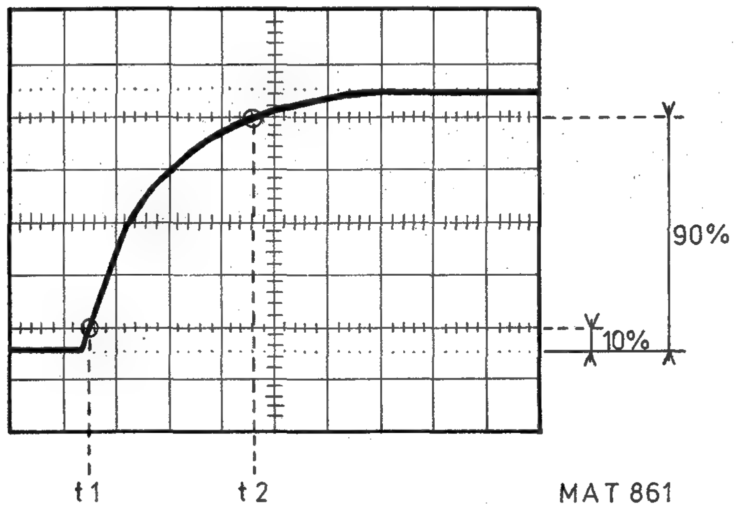


Abb. 1.5. Messung der Anstiegszeit: $t_R = t_2\,(90\%) - t_1\,(10\%)$

1.2.12.4. Vibration

In Betrieb: 15 Minuten entlang jeder der 3 Achsen
0,025" Spitze-Spitze Verlagerung (4 g bei 55 Hz) bei einer Frequenz variierend von 10 Hz nach 55 Hz nach 10 Hz. in Zyklen von einer Minute.

1.2.12.5. Akklimationszeit

Arbeitet innerhalb 30 Minuten, kommend von –10 °C nach Raumbedingungen von +20 °C bei 60 % relativer Luftfeuchte.

1.2.12.6. Magnetische Abschirmung

Nach IEC 351 - 22.3.1.
Maximale Abweichung 1 Teil.

1.2.12.7. Störgrad

Den Vorschriften VDE 0871 und 0875, Störgrad K entsprechend.

1.2.13. Mechanische Daten

1.2.13.1. Abmessungen	Länge	460 mm	Ohne Bedienungsorgane, Deckel und Füsse
	Breite	316 mm	
	Höhe	154 mm	
1.2.13.2. Gewicht	10,9 kg		

1.3. MIT DEM INSTRUMENT GELIEFERTES ZUBEHOR

- Zwei 10:1 passive Tastköpfe.
- Kontrastfilter.
- Frontabdeckung mit Platz für die Ablage von Zubehör, z.B. Tastköpfen.
- Zusammenfaltbare Sichtblende PM9366.
- Bananenstecker/BNC-Adapter PM9051.
- CAL-Anschluss/BNC-Adapter.
- Bedienungsanleitung.

1.4. INFORMATION ZU DEN ALS ZUBEHOR GELIEFERTEN 10:1 PASSIVEN TASTKOPFEN

Diese Tastköpfe mit 10-facher Dämfung sind für die Oszillographen PM 3262, PM 3263, PM 3264 und PM 3266 bestimmt.

1.4.1. Technische Daten

Elektrisch

Abschwächung	10x ±2% (Oszilloskopeingang 1 MΩ± 1%)
Einganswiderstand DC	10 MΩ ± 2% (Oszilloskopeingang 1MΩ ±5%)
AC	Siehe Kurve, Bild 1.6.
Eingangskapazität DC und NF	11 pF ± 1 pF (Oszilloskopeingang 1MΩ ±5% ‖ 13 pF ± 3 pF)
Eingangsreaktanz HF	Siehe Kurve, Bild 1.6.
Bandbreite	Der Tastkopf hat fast kein Einfluss auf die Bandbreite des Oscilloskopes

Max. Eingangsspannung	500 V DC + AC_{Spitze}, minderend mit Frequenz Oszilloskopeingang 1 M Ωund die zwischen der Tastkopfspitze und dem geerdeten Tiel des Tastkopfkörpers angelegte Spannung. Testspannung 1500V, DC über eine Sekunde, bei 15 und 25°C Temperatur und maximal 80% rel. Luftfeuchtigkeit und Meeresspiegelhöhe.
Nullprüfungsknopf Tastkopfgehäuse	Die gleiche Funktion wie der Eingangskopplungs-Schalter des Oszilloskops

Einflussgrössen

Der Tastkopf arbeitet innerhalb der Spezifikationen in folgenden Bereichen:

Temperatur	–25°C bis +70°C
Höhe	Bis auf 5000 m (15 000 Fuss)
Ubrige Einflussgrössen	Die gleichen wie geltend für das Oszilloskop mit welchem der Tastkopf verwendet wird.

Mechanisch

Abmessungen	Tastkopfkörper 103 mm x 10 mm ϕ (max) Kabellänge 1500 mm oder 2500 mm Kompensationsdose 55 x 30 x 15 mm, einschl. BNC
Masse	125 g einschl. Standardzubehör

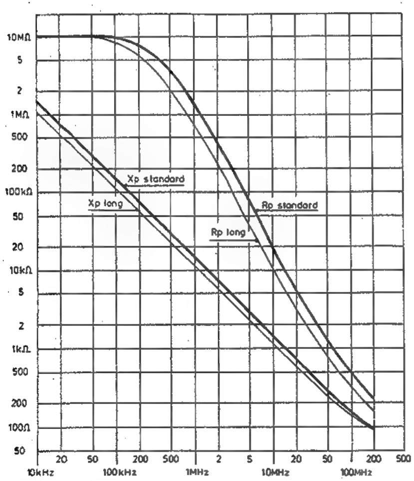


Abb. 1.6. Eingangswiderstand (Rp) und Reaktanz (Xp) gegen Frequenz

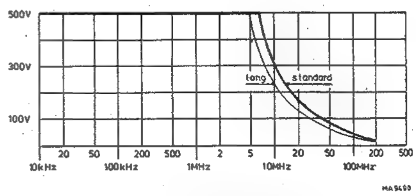


Abb. 1.7. Max.Eingangsspannung-minderung gegen Frequenz

1.4.2. Einstellungen

Anpassen des Tastkopfs an Ihr Oszilloskop

Der Tastkopf wurde vom Hersteller justiert und überprüft. Zur Anpassung des Tastkopfs an das von Ihnen verwendete Oszilloskop sind jedoch nachstehende Handlungen erforderlich.
Den Meszstift mit der CAL Buchse des Oszilloskops verbinden.
Ein Trimmer C2 ist durch eine Offnung in der Kompensationsdose zugänglich und einstellbar um ein optimales Rechtecksignal zu erlangen; vgl. Bild 1.8.b.

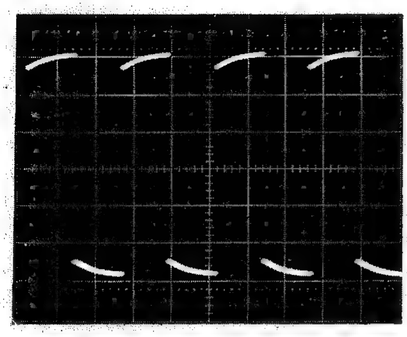


Bild 1.8.a. Überkompensation (Einstellung C2)

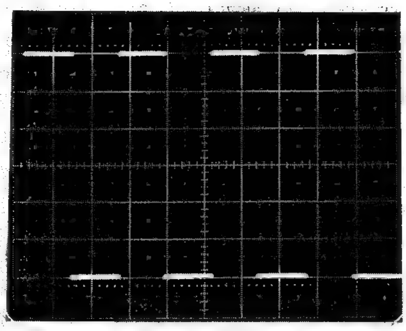


Bild 1.8.b. Einwandfreie Kompensation (Einstellung C2)

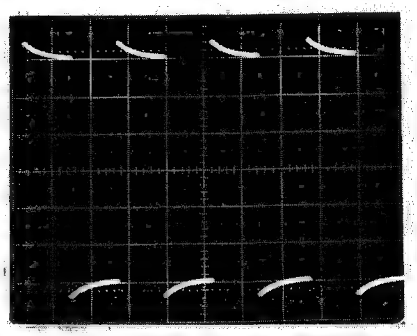


Bild 1.8.c. Unterkompensation (Einstellung C2)

Einstellen des HF Frequenzgang

Die Einstellung des HF Kenlinienkorrektur-Netzwerks zur Anpassung an den Oszilloskopeingang wurde vom Hersteller vorgenommen, so dass Einstellung des HF Kenlinienkorrekturs normalerweise nicht erforderlich ist. Spätere Neueinstellung ist nur dann erforderlich, wenn der Tastkopf mit einem Oszilloskop anderen Typs angewandt wird oder nach dem Ersetzen eines elektrischen Bauteils.
Die Einstellung geschieht wie folgt:
Den Tastkopf an einen schnellen Impulsgenerator (Anstiegszeit nicht über 1 ns), der mit seiner charakteristischen Impedanz abgeschlossen ist, anschliessen. Die Kompensationsdose ausbauen. Den Generator für 100 kHz einstellen. R3 einstellen bis ein wie in Bild 1.9.a. veranschauliches Oszillogramm erhalten wird.
Wichtig ist, dass die ansteigende Flanke so steil und das obere Teil so flach wie möglich ist. Unrichtige Einstellungen von R3 führen zu Impulsverzerrungen wie in Bild 1.9.b. und 1.9.c. ersichtlicht.

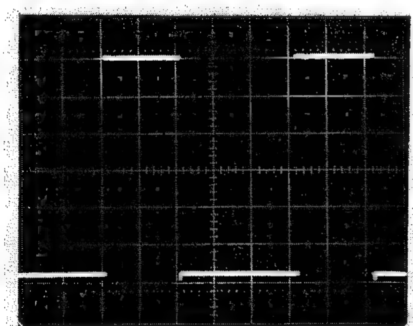


Bild 1.9.a. Voreinstell-Potentiometer einwandfrei eingestellt

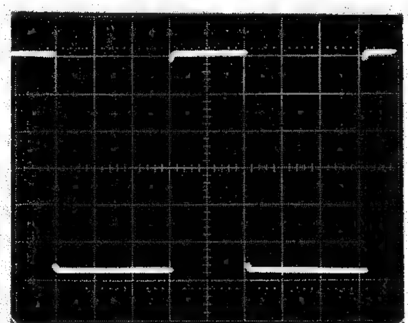


Bild 1.9.b. Rundung als Folge unrichtig eingestellter Potentiometer

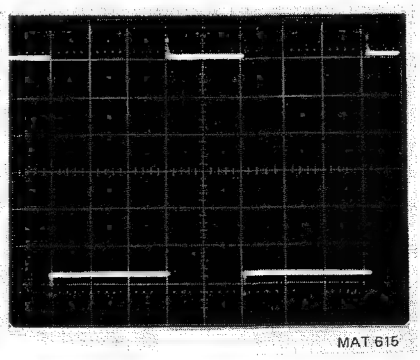


Bild 1.9.c. Überschwingen als Folge unrichtig eingestellter Potentiometer

Bezüglich der Lage des Einstellpunktes R3 auf der Schaltungsplatine in der Kompensationsdose ist Bild 1.12. zu beachten.

1.4.3. Ausbau

Ausbau des Tastkopfs (Bild 1.10.)

Das vordere Teil des Tastkopfs (11) kann vom rückwärtigen Teil (13) abgeschraubt werden. Pos. 11 lässt sich dann von 12 und 13 entfernen.
Die RC-Kombination (12) ist an 13 festgelötet. Betreffend das Ersetzen von 12 siehe Abschnitt "Ersetzen von Teilen".

Ausbau der Kompensationsdose (Bild 1.10.)

Den gerändelten Kragen zwischen Kompensationsdose und Kabel losschrauben. Das Gehäuse 14 lässt sich nun seitwärts von der Kompensationsdose schieben. Die elektrischen Bauteile auf der Platine sind nun zugänglich.

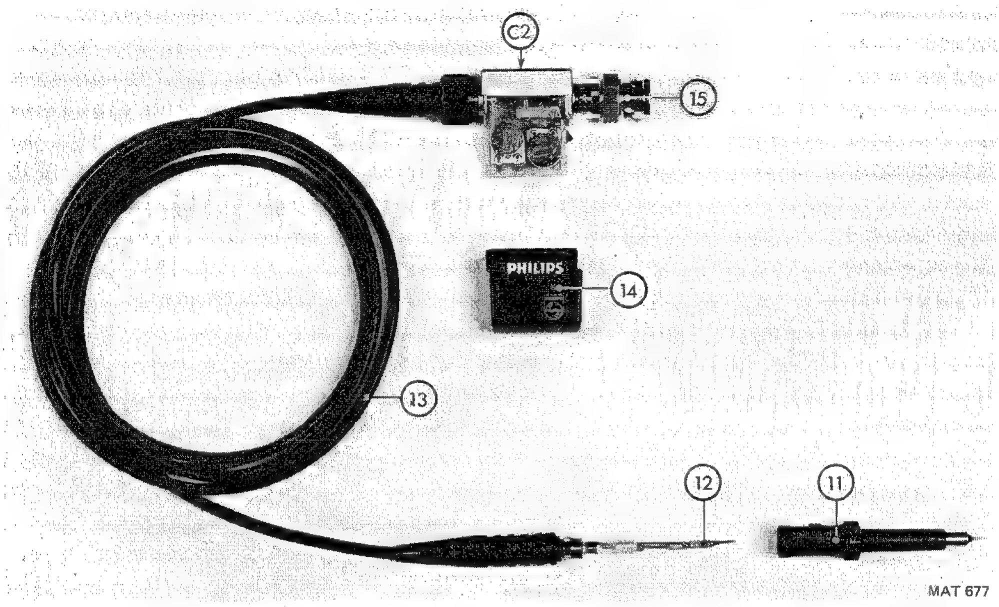


Bild 1.10. Ausbau des Tastkopfs

1.4.4. Ersetzen von Teilen

Zusammenbau des Tastkopfs

Ein neues RC-Netzwerk über das Kabelnippel schieben, danach die Kabelader an den Widerstandsdraht löten.
Bei Zusammenbau des Tastkopfes muss das RC-Netzwerk genau in der Mitte der Tastkopfspitze liegen.

Ersetzen der Kabelzusammenstellung

Die Kompensationsdose ausbauen
Die Verbindung zwischen dem Ihnenleiter und der Platine loslöten. Das Gehäuse der Kompensationsdose festhalten und das Kabelnippel am Sechskantteil mit Hilfe eines 5 mm Schlüssels lösen. Kabel ersetzen und in umgekehrter Arbeitsfolge wieder befestigen.

BNC Ersetzen

Kompensationsdose ausbauen.
Die Verbindung zur Platine loslöten. Die Kompensationsdose festhalten und den BNC mit einem 3/8" Schlüssel lösen. BNC ersetzen und in umgekehrter Arbeitsfolge wieder befestigen.

Ersetzen der Tastkopfspitze

Die beschädigte Spitze mit einer Flachzange herausziehen. Eine neue Spitze muss fest eingedrückt werden.

1.4.5. Ersatzteilliste

1.4.5.1. Mechanische Teile (siehe Bild 1.10. und 1.11.)

Pos. 1 bis 10 sind als Standardzubehör im Lieferumfang des Tastkopfes enthalten.

Pos.	Bestellnummer	Anzahl	Bezeichnung
1	5322 321 20223	1	Erdkabel
2	5322 256 94136	1	Tastkopfhalter
3	5322 255 44026	5	Lötklemmen, die als Routinemesspunkte in Schaltungen einbezogen werden können
4	5322 532 64223	2	Markierungsring, rot
5	5322 532 64224	2	Markierungsring, weiss
	5322 532 64225	2	Markierungsring, blau (nicht abgebildet)
6	5322 268 14017	2	Tastkopfspitzen
7	5322 462 44319	1	Isolierkappe für Abschirmung von Metallteilen des Tastkopfes bei Messungen in dicht verdrahteten Schaltungen
8	5322 462 44318	2	Kappe für Messungen an "Dual in Line" integrierten Schaltungen
9	5322 264 24018	1	Wickelstift (Wrap-pin)-Adapter
10	5322 264 24019	1	Feder-Testklemme
11	5322 264 24021	1	Tastkopfumhüllung mit Nullprüftaste
12	5322 216 54152	1	RC-Netzwerk
13	5322 320 14063	1	Kabel-Zusammenstellung
14	5322 447 64015	1	Abdeckkappe
15	5322 268 44019	1	BNC-Steckverbindung

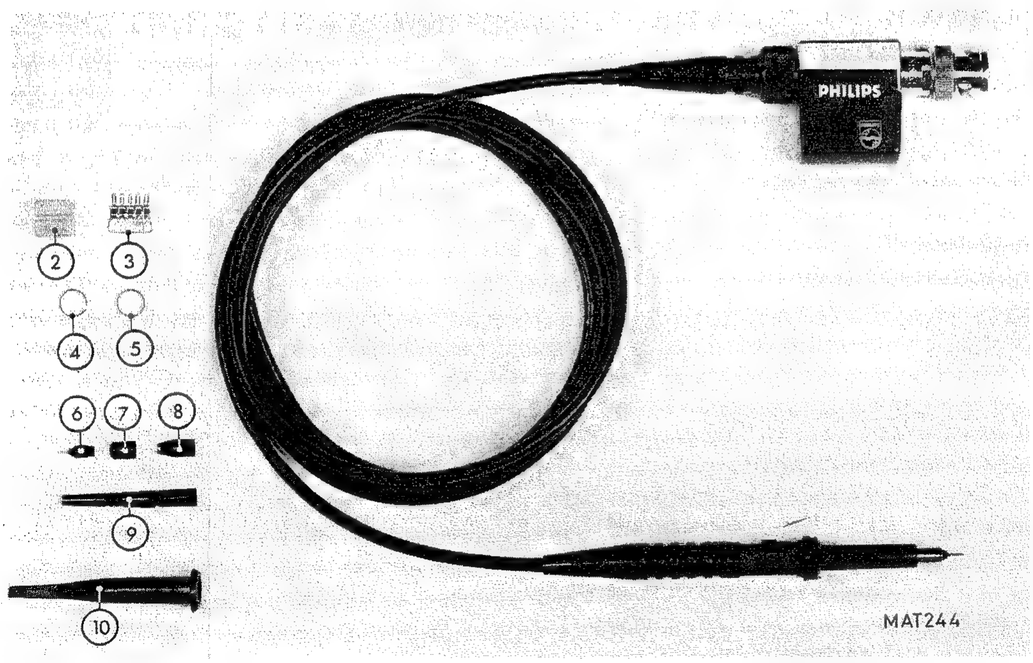


Bild 1.11. Mechanische Teile des Tastkopfs

1.4.5.2. Elektrische Teile (siehe Bild 1.12.)

Pos.	Bestellnummer	Bezeichnung
C1	–	Teil des RC-Netzwerks (wird nicht gesondert geliefert).
C2	5322 125 54003	Trimmer 60pF/300 Volt.
C3	–	Kapazität 2,7pF.
L1	–	Spule 5,5 Windungen, Draht 0,4 mm. diameter.
R1	–	Teil des RC-Netzwerks (wird nicht gesondert geliefert).
R2	5322 116 50536	Metallschichtwiderstand 464Ω, 1%, MR25.
R3	5322 101 14047	Potentiometer 470Ω, 20%.
R4	5322 116 50536	Metallschichtwiderstand 464Ω, 1%, MR25.
R5	5322 116 54462	Metallschichtwiderstand 82,5Ω, 1%, MR25.

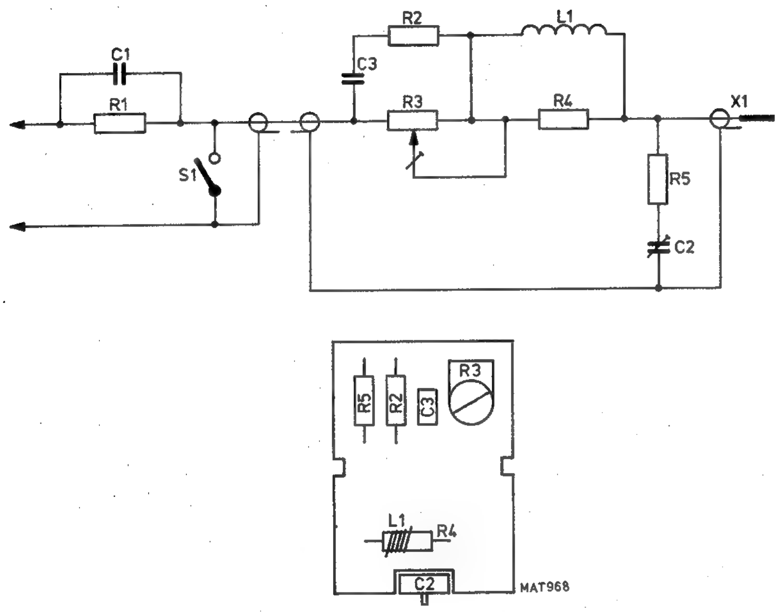


Bild 1.12. Elektrische Teile des Tastkopfs und Anordnung der Leiterplatte

1.5. BESCHREIBUNG DES FUNKTIONELLEN BLOCKDIAGRAMS

1.5.1. Vertikal-Ablenkung

Das Gerät besitzt zwei identische Kanäle A und B, für die jeweils für die Signale an den Eingängen A und B eine Signalkontrolle und - verstärkung möglich ist. Der Einfachheit halber erfolgt lediglich eine Beschreibung für den Kanal A.

Der Kanal A besitzt einen Eingangssignal—Kopplungsschalter AC/O/DC, einen Schalter AMPL/DIV zur Einstellung der Signalverstärkung bzw. des vertikalen Ablenk-Koeffizienten und einen Einsteller POSITION, der mit einem Zug-Druck-Schalter NORMAL/INVERT zusammengefasst ist. Bei den drei Schaltstellungen des Schalters AC/O/DC wird das Eingangssignal in der Schaltstellung AC an den Verstärkereingang über einen Gleichspannungsblockierkondensator angelegt; in der Schaltstellung O wird das Eingangssignal unterbrochen und in der Schaltstellung DC wird das Signal direkt an den Verstärkereingang angelegt. Der Einsteller POSITION ist ein Potentiometer, durch dessen Verdrehen eine kontinuierliche Vertikal-Verschiebung des Signals auf dem Bildschirm herbeiführbar ist. Durch Drücken bzw. Ziehen an dem Einsteller POSITION besteht ausserdem die Möglichkeit, das Signal "NORMAL" oder "INVERTIERT" darzustellen.

Das Triggern der Zeitbasis für ein von einem der Vertikal-Kanäle abgeleitetes Signal ist über den Block A/B/ COMPOSITE TRIGGER SWITCHING möglich.

Mit dem Schalter VERTICAL CHANNEL ist es möglich, das Ausgangssignal des Kanals A zu der Verzögerungsleitung (DELAY LINE) und zu dem Endverstärker für die Vertikalablenkung (FINAL VERTICAL AMPLIFIER) durchzuschalten oder das Signal zu blockieren. Andere Signalquellen für die Verzögerungsleitung und den Endverstärker sind die Ausgangssignale des Kanals B oder des Blocks TRIGGER VIEW AMPLIFIER. Dieses Signal ist das Triggersignal für den Haupttakt und stammt aus der Haupttakt-Triggerquelle. Wenn die Kanäle A und B gleichzeitig durchgeschaltet sind, werden die Ausgangssignale dieser Kanäle addiert und auf dem Bildschirm erfolgt eine Darstellung des Summensignals. Der Schalter VERTICAL CHANNEL wird von der VERTICAL DISPLAY MODE LOGIC gesteuert, die ihrerseits von der Einstellung der vertikalen Darstellungsart A, ALT, TRIG VIEW, CHOP, ADD, B gesteuert wird. Wenn mehr als ein Kanal dargestellt wird, dann kann die Anzeige in den Funktionen CHOPped oder ALTernate erfolgen, d.h. zerhackt oder alternierend. Für die alternierende Darstellung wird dabei ein von der Hauptzeitbasis (MAIN TIME BASE) abgeleitetes Signal verwendet.

Die Verzögerungsleitung (DELAY LINE) sorgt für die erforderliche Signalverzögerung, so dass die Vorderflanke eines schnellen Signalphänomens auf dem Bildschirm dargestellt werden kann.

Der Endverstärker für die Vertikalablenkung (FINAL VERTICAL AMPLIFIER) dient der Ansteuerung der Vertikal-Ablenkplatten der Elektronenstrahlröhre. Bei der Betriebsart mit alternierendem Takt ermöglicht die TRACE SEParation-Steuerung eine unterschiedliche Einstellung der Vertikalablenkung für das Hauptzeitbasissignal und das verzögerte Zeitbasissignal zum Erleichtern eines Vergleichs.

1.5.2. Horizontal-Ablenkung

Als Signalquelle für den Endverstärker für die Horizontal-Ablenkung (FINAL HORIZONTAL AMPLIFIER) können die Hauptzeitbasis (MAIN TIME BASE), die verzögerte Zeitbasis (DELAYED TIME BASE) und das Ausgangssignal des Horizontal-Ablenkverstärkers (HORIZONTAL DEFLECTION AMPLIFIER) ausgewählt werden.

Die Wahl der Signalquelle erfolgt über den Horizontal-Kanalschalter (HORIZONTAL CHANNEL SWITCH), der seinerseits durch die Logik zur Wahl der horizontalen Darstellungsart (HORIZONTAL DISPLAY MODE LOGIC) gesteuert wird, welche ihrerseits durch die Einstelleinrichtungen für die horizontale Betriebsart mit dem Schaltmöglichkeiten DELD TB, ALT TB, EXT X DEFL und MAIN TB.

Sowohl die Hauptzeitbasis wie auch die verzögerte Zeitbasis können eine zeitlineare Sägezahnspannung erzeugen, deren Anstiegszeit mit Hilfe eines Einstellers TIME/DIV einstellbar ist.

HAUPTZEITBASIS–TRIGGERQUELLE/FILTER/TRIGGERVERSTÄRKER:

Die Hauptzeitbasis kann durch die Kanäle A oder B, durch ein mit der Netzspannung verknüpftes Signal aus dem Netzteil oder durch ein an den externen Triggereingang EXT TRIG OR X DEFL angelegtes Signal getriggert werden. Die gewünschte Triggerquelle kann durch Schalter für den Block TRIGGER SOURCE ausgewählt werden. Das ausgewählte Triggerquellensignal kann mit einem Niederfrequenzfilter oder einem Hochfrequenzfilter gefiltert oder, wenn die DC-Taste des DC/LF/HF-Einstellers gedrückt ist, ungefiltert zugeführt werden. Der Pegel und die Steigung mit der die Hauptzeitbasis anläuft, können durch den Einsteller LEVEL/SLOPE vorgegeben werden. Die ausgewählte Hauptzeitbasis-Triggerquelle kann auch für den Horizontal-Ablenkverstärker und über den Vertikal-Kanalschalter für die Einheit TRIGGER VIEW verwendet werden.

VERZÖGERTE ZEITBASIS–TRIGGERQUELLE/FILTER/TRIGGERVERSTÄRKER

Die verzögerte Zeitbasis kann von Kanal A oder B oder einem Signal am externen Triggereingang EXT TRIG getriggert werden. Ferner lassen sich die Ankopplung des Signals mit DC/LF/HF sowie LEVEL/SLOPE einstellen.
Im KOMPARATOR wird das Sägezahn-Signal der Hauptzeitbasis mit einer einstellbaren Gleichspannung vom Potentiometer DELAY TIME verglichen. In dem Augenblick, in dem die Sägezahnspannung mit der eingestellten Gleichspannung übereinstimmt, gibt der KOMPARATOR ein Signal an die verzögerte Zeitbasis. Ist die Taste MAIN TB des Triggerquellen-Wahlschalters gedrückt, startet die verzögerte Zeitbasis nun direkt. Ist eine der Tasten A, B oder EXT des Triggerquellen-Wahlschalters gedrückt, startet die verzögerte Zeitbasis, sobald nach dem Signal vom KOMPARATOR ein Triggerimpuls von der gewählten Triggerquelle eintrifft.

1.5.3. Z- und Fokussierabschnitt

Der Z-Verstärker erhält Eingangssignale, die über den Wehnelt-Zylinder G1 der Elektronenstrahlröhre die Helligkeit des Leuchtflecks auf dem Schirm bestimmen. Ausserdem wird die Fokussierung des Leuchtflecks gesteuert. Die Elektronenstrahlröhre besitzt getrennte Elektroden für die Fokussierung in vertikaler Richtung (G5) und in horizontaler Richtung (G3). Die Spannungen an diesen Elektroden werden von dem vertikalen Fokussierverstärker bzw. dem horizontalen Fokussierverstärker geliefert. Beide Verstärker erhalten ihr Eingangssignal vom Z-Verstärker.
Der horizontale Fokussierverstärker lässt sich mit dem Knopf FOCUS an der Frontplatte beeinflussen.
Folgende Signale steuern die Helligkeit und die Fokussierung des Leuchtflecks:

- die Stellung des Knopfes INTENS an der Vorderseite des Geräts.
- bei zerhackter Darstellung ein Austastsignal von der vertikalen Anzeigelogik.
- ein von der Hauptzeitbasis kommendes Austastsignal für die Dunkelsteuerung des Elektronenstrahls während der Sperrperiode (hold off period) der Hauptzeitbasis.
- ein vom Horizontalkanal-Schalter kommendes Signal für den aufgehellten Teil des Signals von der verzögerten Zeitbasis in dem Signal der Hauptzeitbasis.
- ein Signal, das an den externen Z-Modultationseingang Z-MOD angeschlossen ist.
- ein Signal vom Speichersystem zum Dunkeltasten der Anzeige, wenn kein Signal eingeschrieben wird.

1.5.4. Speichersystem und Prinzip der Speicherung

Das Oszilloskop besitzt eine spezielle Speicherröhre. Das Speichersystem besteht aus einem vorderen Speichernetz (FRONT MEMORY MESH), einem schnellen Speichernetz (FAST MEMORY MESH) und den Flutkanonen (FLOOD GUNS).
Die beiden Speichernetze sind Metallgitter, die hintereinander in einem Abstand von ein paar Millimetern hinter dem Schirm angeordnet sind. An der Seite des Gitters, die zur Elektronenkanone gerichtet ist, ist eine Schicht aus dielektrischem Material aufgetragen. Die Speicherwirkung beruht auf Sekundäremission in der dielektrischen Schicht. An den Stellen, an denen hochenergetische Elektronen von der Elektronenkanone auf das Speichernetz auftreffen, verlassen mehr Elektronen das Netz als dort auftreffen: diese Stellen werden positiv geladen. Die Flutkanonen erzeugen nun eine Wolke von niederenergetischen Elektronen, die das ganze Speichernetz bestrahlt. Diese Elektronen können das Speichernetz an den Stellen durchdringen, an denen es positiv geladen ist.
Nach Durchlaufen des Netzes werden sie von der sehr hohen positiven Spannung der Nachbeschleunigungselektrode angezogen. Auf diese Weise erhält man ein Abbild des Ladungsmusters des Speichernetzes auf dem Schirm.

Bei der Betriebsart (MAX) WRITE wird nur das vordere Speichernetz beschrieben. Dieses Netz ist für schnelle Signale weniger geeignet, doch dafür bleibt die eingeschriebene positive Ladung längere Zeit erhalten.

In der Betriebsart FAST werden sowohl das schnelle Speichernetz als auch das vordere Speichernetz benutzt. Das schnelle Speichernetz ist so beschaffen, dass sehr schnelle Signale eingeschrieben werden können. Die hierdurch entstehende positive Ladung bleibt aber nur kurze Zeit erhalten. Deshalb wird das Ladungsmuster des schnellen Speichers sogleich (am Ende jeder Horizontalablenkung) mit Hilfe der Flutkanonen auf das vordere Speichernetz übertragen. Man nennt dies die Bildübertragung (IMAGE TRANSFER). Nach dieser Übertragung wird das Abbild des Ladungsmusters des vorderen Speichernetzes auf dem Schirm dargestellt.

Die Bildübertragung wird mit einer Reihe von Impulsen gesteuert, die dem vorderen Speichernetz, dem schnellen Netz und den Flutkanonen zugeführt werden. Ebenfalls müssen für das Löschen des Ladungsmusters in den Speichernetzen bestimmte Impulse an die Elektroden des Speichersystems gegeben werden. Alle Impulse, die für die Funktion des Speichersystems bei den einzelnen Betriebsarten erforderlich sind, werden in der Speicherlogik (STORAGE LOGIC) erzeugt und dann in den Speicherverstärkern (STORAGE AMPLIFIERS) auf das gewünschte Potential gebracht.
Die Speicherlogik wird von dem Betriebsartenschalter STORE, MEMORY OFF, WRITE, FAST, ERASE und den Knöpfen PERSISTENCE/VIEW TIME und INTENS gesteuert.

1.5.5. Netzteil

Das Netzteil ist stabilisiert und erzeugt die Versorgungsgleichspannungen für die elektronischen Schaltkreise des Geräts, die hohe positive Spannung für den ersten Beschleuniger der Elektronenstrahlsöhre und die hohe negative Spannung für die Kathode derselben.
Ausserdem liefert der Netzteil ein mit der Netzspannung verknüpftes Signal zum Triggern der Hauptzeitbasis.

2. INSTALLIERUNGSANLEITUNGEN

2.1. WICHTIGE SICHERHEITSBEDINGUNGEN (DEN IEC 348 VORSCHRIFTEN ENTSPRECHEND)

Vor Anschluss des Geräts an das Netz ist eine Sichtkontrolle vorzunehmen, um eine mögliche Beschädigung des Geräts während des Transports feststellen zu können. Wenn irgendwelche Defekte wahrgenommen werden, darf das Gerät **nicht** an das Netz angeschlossen werden.

REKLAMATIONEN: Im Falle offensichtlicher Beschädigungen oder Mängel oder wenn der sicherheitstechnische Zustand zweifelhaft erscheint, muss beim Überbringer sofort reklamiert werden. Eine Philips Verkaufs- oder Servicestelle muss ebenfalls verständigt werden um Reparatur des Geräts zu ermöglichen.

Vor dem Anschliessen muss der Erdschutzanschluss mit einem Schutzleiter verbunden werden (siehe 2.4. "Erdung").

WARNUNG: Beim Öffnen von Abdeckungen oder Entfernen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend und somit Lebensgefährlich sein.

Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein.
Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft geschehen, welche die damit verbundene Gefahren kennt.
Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde, die Schaltbilder sind zu beachten.

2.2. ABNEHMEN UND AUFSETZEN DER FRONT-ABDECKHAUBE (siehe Bild 2.1.)

Abnehmen

- Den Knopf in der Mitte des Deckels eindrücken und eine viertel Umdrehung nach links drehen (Stellung UNLOCKED).
- Deckel abnehmen.

Aufsetzen

- Den Verriegelungsknopf eindrücken und in Stellung UNLOCKED drehen.
- Deckel an der Vorderseite des Oszillografen befestigen.
- Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED).

2.3. BETRIEBSLAGE DES GERÄTS

Das Gerät darf in beliebiger Lage betrieben werden. Mit dem Tragbügel nach unten geschwenkt kann das Gerät in Schrägstellung benutzt werden. Die elektrischen Kenndaten nach Abschnitt 1.2. sind für jede Betriebslage des Geräts garantiert. Es ist darauf zu achten, dass die Deckel- und Bodenabdeckung frei sind.
Das Gerät nie auf eine Wärmeerzeugende oder ausstrahlende Oberfläche stellen oder direkter Sonnenstrahlung aussetzen.
Der Tragbügel lässt sich drehen, wenn die Lagerzapfenknöpfe eingedrückt werden.

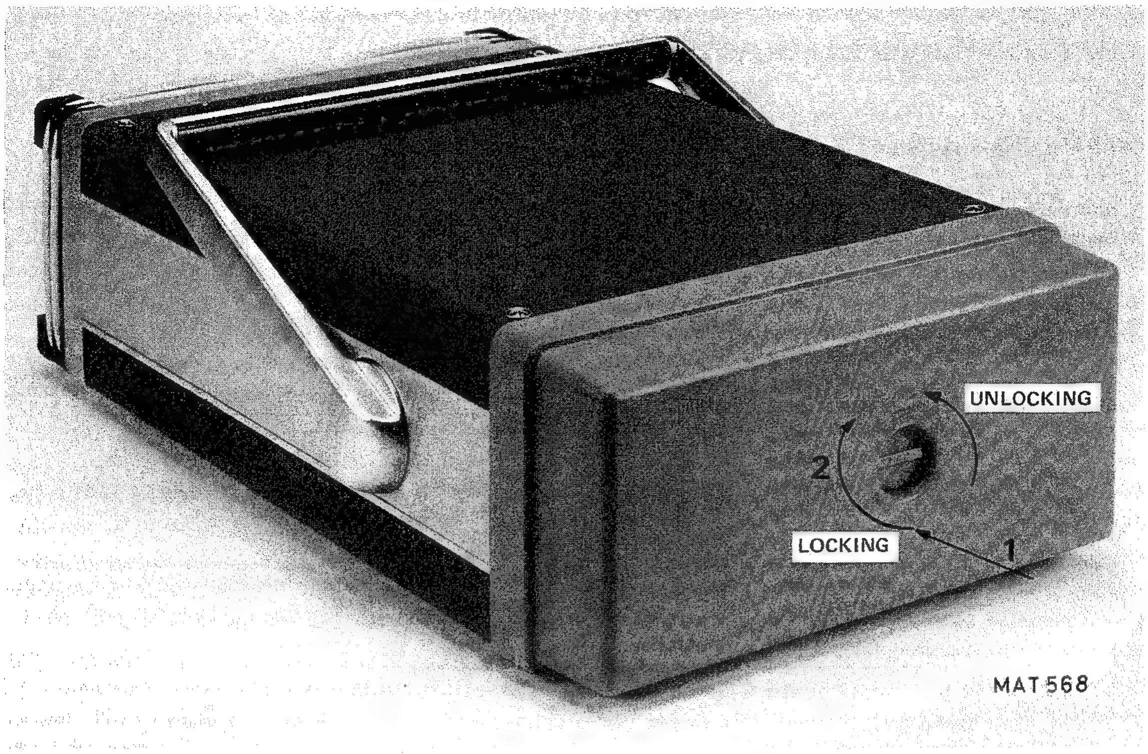


Bild 2.1. Abnehmen der Abdeckhaube

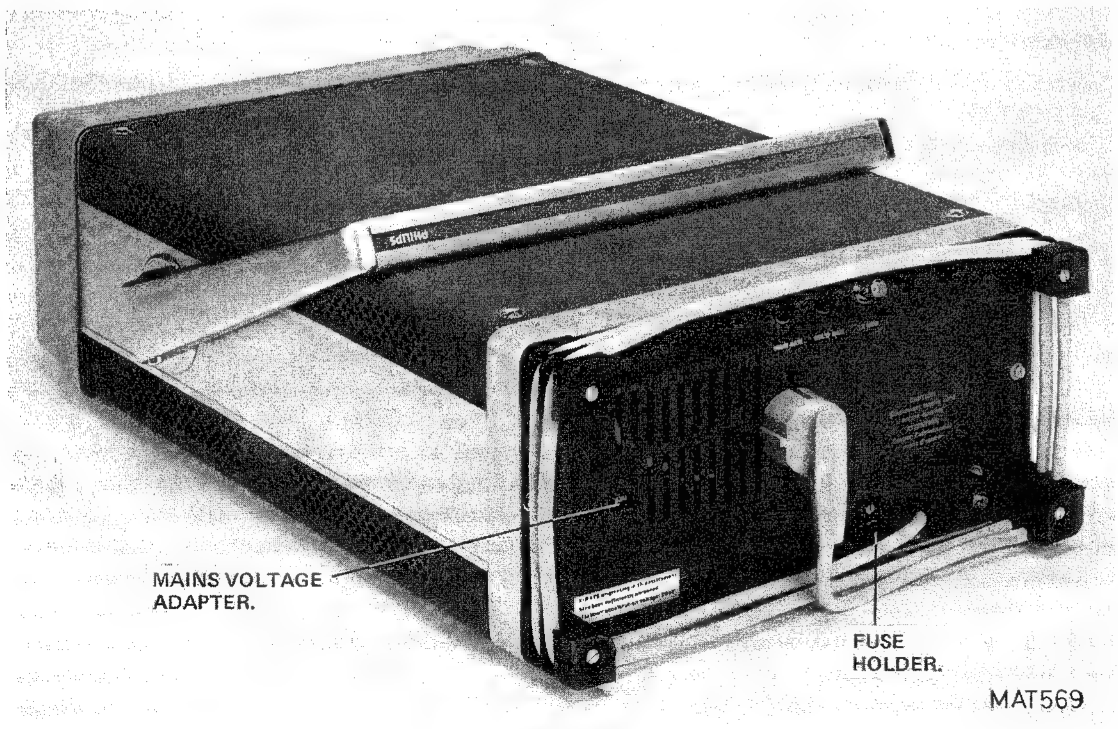


Bild 2.2. Rückansicht des Geräts

2.4. ERDUNG

Vor dem Einschalten muss das Gerät auf eine der folgenden Weisen mit einem Erdschutzleiter verbunden werden:

- über den Schutzerdeanschluss;
- über das dreiadrige Netzkabel. Der Netzstecker darf nur in eine Schutzkontaktdose eingeführt werden. Die Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch eine Verlängerungsleitung ohne Schutzleiter.

WARNUNG:	Jede Unterbrechung des Schutzleiters innerhalb oder ausserhalb des Geräts oder Trennung vom Schutzerdeanschluss ist gefährlich und deshalb unzulässig.

Wenn ein Gerät von kalter in warme Umgebung gebracht wird, kann durch Kondensation ein sicherheitstechnisch gefährlicher Zustand entstehen. Deshalb sind die Erdungsvorschriften genauestens zu beachten.

2.5. EINSTELLEN DER NETZSPANNUNG UND SICHERUNG

Vor Einführen des Netzsteckers in die Netzbuchse ist zu kontrollieren ob das Gerät für die örtliche Netzspannung eingestellt ist.

Das Gerät ist bei zwei Netzspannungsbereichen betriebsfähig nämlich: 100 ... 127 V Wechselspannung (± 10 %) und 220 ... 240 V Wechselspannung (± 10 %).
Letzter Spannungsbereich wird auch angewandt wenn das Gerät mit einer Gleichspannung zwischen 250 und 350 V betrieben wird. Jeder der beiden Spannungsbereiche ist mit Hilfe des Schiebeschalters, welcher sich hinter dem Fenster an der Geräterückseite befindet, einstellbar. Der gewählte Spannungsbereich ist durch das Fenster sichtbar (siehe Bild 2.2.).
Bevor man Zugang zum Spannungsumschalter erlangen will, muss das Gerät von allen Spannungsquellen getrennt sein. Der Schalter wird nach Abnahme der Geräterückwand zugänglich (die beiden Schrauben lösen).
Das Gerät ist gegen unrichtige Einstellung des Spannungsumschalters geschützt.
Der an der Rückwand angebrachte Sicherungshalter enthält eine Sicherung, 2 A, träge.
Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden. Die Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherungshalter sind nicht zulässig. Das Gerät muss von allen Spannungsquellen getrennt sein wenn eine Sicherung ersetzt wird.

Es dürfen nur Sicherungen des vorgeschriebenen Wertes und Typs verwendet werden. Verwendung reparierter Sicherungen und Kurzschliessen des Sicherungshalters ist nicht zulässig. Beim Ersetzen von Sicherungen oder beim Umschalten auf eine andere Netzspannung muss das Gerät von allen Spannungsquellen getrennt sein.

3. BETRIEBSANLEITUNG

3.1. ALLGEMEINES

Dieser Abschnitt gibt einen Überblick der für die Inbetriebnahme des Geräts erforderlichen Handlungen und Vorsichtmassregeln. Er beschreibt und erläutert in Kürze die Funktion der Bedienungsorgane auf Frontplatte und Rückwand sowie der Anzeigen. Ausserdem sind hier die praktischen Gesichtspunkte der Bedienung erklärt, dies ermöglicht dem Bedienungsmann eine rasche Bewertung der Hauptfunktionen des Geräts.

3.2. EINSCHALTUNG

Nach dem Anschluss des Oszilloskops an das Netz, gemäss Abschn. 2.4. und 2.5., kann es mit Schalter **POWER** eingeschaltet werden.

Der Schalter POWER (Netzschalter) ist gekoppelt an ILLUM auf der Frontplatte unter dem Bildröhrenrahmen. Die zugehörige POWER ON/OFF Anzeigelampe befindet sich neben dem ILLUM/POWER Schalter.

Das Oszilloskop ist sofort nach Einschaltung betriebsfähig. Bei normaler Installierung nach Abschnitt 2 und nach 30 Minuten Anwärmzeit gelten die Abschnitt 1.2. gegebenen Kenndaten.

WARNUNG:	**Das Oszilloskop darf niemals eingeschaltet werden, wenn eine Leiterplatte entfernt ist. Eine Leiterplatte immer erst dann entfernen, wenn das Oszilloskop zumindest eine Minute ausgeschaltet ist.**

3.3. BESCHREIBUNG DER BEDIENUNGSORGANE UND BUCHSEN (siehe Abb. 3.1.)

3.3.1. Vertikalkanäle

A, ALT, TRIG VIEW, CHOP, ADD, B (S1)	Einstellung der vertikalen Darstellungsarten, Drucktastenschalter mit 6 Stellungen.
A eingedrückt	Vertikalablenkung durch an Kanal A gelegtes Signal.
ALT eingedrückt	Das Bild wird am Ende (jeder Periode) des Zeitablenksignales von einem Vertikalkanal auf den anderen umgeschaltet, das heisst Kanäle A und B werden auf ALTernierender Ablenkung dargestellt.
TRIG VIEW eingedrückt	Die Anzeige wird für Sichtbarmachung des gewählten Triggersignal geschaltet. Darstellung des Triggersignals ist inter über A oder B kanal möglich (A oder B von S22 eingedrückt) oder extern über die externe Eingangsbuchse X7, wenn EXT oder EXT ÷ 10 von S22 eingedrückt ist.
CHOP eingedrückt	Das Bild wird mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet, die beiden Kanäle A und B während der gleichen Ablenkung sichtbar.
ADD eingedrückt	Vertikalablenkung durch die Summe der Signale von Kanal A und B.
B eingedrückt	Vertikalablenkung durch Signal von Kanal B
Keine der Tasten betätigt	Wird keine Taste eingedrückt ist die Betriebsweise des Gerätes wie bei Einstellung ALT.
ALT und TRIG VIEW gleichzeitig eingedrückt	Die Signale auf den Kanälen A, B und TRIG VIEW werden bei alternierenden Ablenkung dargestellt, normalerweise für Hochfrequenzsignale geeignet (siehe auch die Erklärung der Drucktaste TRIG VIEW).

CHOP und TRIG VIEW gleichzeitig eingedrückt	Die Triggersignale auf den Kanälen A und B sind eines nach dem anderen bei CHOP Frequenz während der gleichen Ablenkung sichtbar, normalerweise für Niederfrequenzsignale geeignet. (siehe auch die Erklärung der Drucktaste TRIG VIEW)
POSITION (R3, R4)	Stufenlose Einstellung der vertikalen Lage des Bildes
PULL TO INVERT (S4, S5)	Zweiweg Zug-Druckschalter gekoppelt an Einsteller POSITION zur Umkehrung der Signalpolarität. Eindrücken für NORMAL ziehen für INVERT
AMPL/DIV (S9, S11)	Stufenweise Einstellung der Vertikalablenkkoeffizienten mit 11 Stellungen.
UNCAL (V4, V5)	Lampenanzeige dass sich der Einsteller CAL nicht in Kalibrierstellung befindet.
CAL (AMPL/DIV) (R8/S10,R9/S12)	Stufenlose Einstellung der Vertikalablenkkoeffizienten. In Stellung CAL ist der eingestellte Ablenkkoeffizient kalibriert
GAIN (R12, R13) (Schraubenzieher-einstellung)	Stufenlose Einstellung der Gesamtverstärkung der Vertikal-kanäle.
AC, 0, DC (S17, S18)	Signalkopplung, Schalter mit 3 Stellungen.
AC gewählt	Kopplung über einen Sperrkondensator.
0 gewählt	Verbindung zwischen Eingangsschaltung und Eingangsbuchse wird unterbrochen und der Verstärkereingang geerdet.
DC gewählt	Direkte Kopplung Ist keine Taste eingedrückt so gilt Einstellung AC. Für die Beobachtung von langzeitigen Impulsen oder von Gleichspannungspegeln von Signalformen ist es ratsam Stellung DC zu wählen. Stellung AC ist für Wechselspannungssignale mit beträchtlichen Gleichspannungsanteil zu wählen.
A 1 MOhm - 15 pF (X3)	BNC Eingangsbuchse für Kanal A
B 1 MOhm - 15 pF (X4)	BNC Eingangsbuchse für Kanal B

3.3.2. Horizontaler Kanal

DEL'D TB, ALT TB, EXT X DEFL, MAIN TB (S2)	Einstellelemente für horizontale Darstellungsart, Drucktastenschalter mit 4 Stellungen.
DEL'D TB eingedrückt	Die Horizontalablenkspannung wird vom verzögerten Zeit-ablenkgenerator geliefert.
ALT TB eingedrückt	Die horizontale Darstellung wird am Ende jedes Zyklus des Hauptzeitablenkgenerators von der Hauptzeitablenkung auf verzögerte Zeitablenkung umgeschaltet. Nicht wirksam wenn TRIG VIEW eingedrückt oder wenn die verzögerte Zeitbasis auf "OFF" geschaltet ist.
EXT X DEFL eingedrückt	Horizontalablenkung durch ein an die Eingangsbuchse (X7) des Horizontalverstärkers gelegtes Signal, durch ein von Kanal A oder B kommendes Signal, das zusammengesetzte Signal oder Netzfrequenzsignal, je nach Einstellung von TRIG or X DEFL (S22).
MAIN TB eingedrückt	Horizontalablenkspannung wird vom Hauptzeitablenkgenerator geliefert; ein Teil der Darstellung wird aufgehellt (Ausgenommen in Stellung OFF des TIME/DIV Schalters des verzögerten Zeit-ablenkgenerators). **Ist keine Taste eingedrückt** so gilt Einstellung MAIN TB.

POSITION TB MAGN (R2, S3)	Stufenlose Einstellung der horizontalen Lage des Bildes; gekoppelt mit einem Zug-Druck-Schalter der den Horizontalablenkkoeffizienten 10 mal steigert (PULL FOR X10).
MAGN (V3)	Eine Signallampe leuchtet auf wenn die X10 Dehnung wirksam ist.
X AMPL, HOLD OFF (R18)	Stufenlose Einstellung des Horizontalablenkkoeffizienten bei externer X-Ablenkung. Bei X-Ablenkung durch die Hauptzeitablenkung kann diese Einstellung zur Steigerung der Sperrzeit benutzt werden.
TRACE STEP (R6)	Stufenlose regelbare Voreinstellung des vertikalen Abstands zwischen den beiden Zeitablenkungs-Darstellungen in Betriebsart ALT TB.

3.3.3. Hauptzeitablenkgenerator

LEVEL-SLOPE (R7, S7)	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales (gedrückt "+", gezogen "–").
NOT TRIG'D (V2)	Signallampe leuchtet auf wenn die Zeitablenkung nicht getriggert ist, z.B. bei Wartestellung.
AUTO, TRIG, SINGLE (S8)	Triggerart-Einstellungen; Drucktastenschalter mit 3 Stellungen.
AUTO eingedrückt	Liegt kein Triggersignal an so läuft der Hauptzeitablenker frei.
TRIG eingedrückt	Der Zeitablenkgenerator wird auf normale Weise getriggert.
SINGLE eingedrückt	Nach Betätigung der Taste SINGLE läuft der Zeitablenkgenerator nach Empfang eines Triggersignals nur einmal ab. Wenn keine Taste gedrückt ist gilt Betriebsart SINGLE.
TIME/DIV or DELAY TIME (S15)	Einstellung des Zeitkoeffizienten der Hauptzeitablenkung; Drehschalter mit 23 Stellungen.
CAL (blau) - TIME/DIV (R11, S16)	Stufenlose Einstellung des Zeitkoeffizienten der Hauptzeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
UNCAL (V6)	Signallampe zeigt an dass sich Einsteller CAL nicht in Kalibrierstellung befindet.
DC, LF, HF (S20)	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC eingedrückt	Triggersignale direkt gekoppelt.
LF eingedrückt	Kopplung über Tiefpass für Frequenzen bis 30 kHz (Für externe Triggerung über einen Bandfilter von 7 Hz bis 30 kHz).
HF eingedrückt	Kopplung über Hochpass für Frequenzen über 30 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
TRIG or X DEFL (S22)	Wähler für Triggerquelle oder externe X Ablenkung. Drucktastenschalter mit 4 Stellungen.
A eingedrückt	Internes Trigger- oder X-Ablenksignal von Kanal A.
B eingedrückt	Internes Trigger- oder X-Ablenksignal von Kanal B.
COMP (A und B gleichzeitig eingedrückt)	Internes Trigger- oder X-Ablenksignal von Kanälen A und B.
EXT	Triggerung auf externes Signal über angrenzende 1 MOhm - 15 pF Buchse (X7). Durch Eindrücken der Taste EXT X DEFL der Horizontalablenkungs-Einstellung wird diese Buchse mit dem Eingang des Horizontalverstärkers verbunden.

EXT ÷ 10	Triggerung und Horizontalablenkung wie bei EXT, jedoch um den Faktor 10 abgeschwächt.
LINE (EXT und EXT ÷ 10 gleichzeitig gedrückt)	Triggerung- oder X-Ablenkungssignal abgeleitet von einer internen Spannung mit der Netzfrequenz. Ist keine Taste eingedrückt so gilt Einstellung A. Wenn keine Taste gedrückt ist, ist keine Betriebsart gewählt.
1 MOhm - 15 pF (X7)	BNC Buchse für externe Triggerung oder Horizontalablenkung.

3.3.4. Verzögerter Zeitablenkgenerator

DELAY TIME Multiplizierter (R1)	Stufenlose Einstellung der Verzögerungszeit, wirkt zusammen mit der TIME/DIV Einstellung des Hauptzeitablenkgenerators.
LEVEL-SLOPE (R5, S6)	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales (gedrückt "+", gezogen "–").
TIME/DIV (S13)	Einstellung des Zeitkoeffizienten der verzögerte Zeitablenkung Drehschalter mit 23 Stellungen. In Stellung OFF wird die verzögerte Zeitablenkung abgeschaltet.
CAL (blau) - TIME/DIV (R10, S14)	Stufenlose Einstellung des Zeitkoeffizienten der verzögerten Zeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
UNCAL (V6)	Signallampe zeigt an dass sich Einsteller CAL nicht in Kalibrierstellung befindet.
DC, LF, HF (S19)	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC eingedrückt	Triggersignale direkt gekoppelt.
LF eingedrückt	Kopplung über Tiefpass für Frequenzen bis 30 kHz (für externe Triggerung über einen Bandfilter von 7 Hz bis 30 kHz).
HF eingedrückt	Kopplung über Hochpass für Frequenzen über 30 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
A, B, EXT, MAIN TB (S21)	Triggerquellen Einstellung und Startpunkt der verzögerten Zeitablenkung Drucktastenschalter mit 4 Stellungen.
A eingedrückt	Internes Triggerungssignal von Kanal A nach Verzögerungszeit.
B eingedrückt	Internes Triggerungssignal von Kanal B nach Verzögerungszeit.
EXT eingedrückt	Triggerung auf ein externes Signal über angrenzende 1 MOhm-15 pF Buchse.
MAIN TB eingedrückt	Die verzögerte Zeitablenkung startet sofort nach Verstreichen der Verzögerungszeit. Ist keine Taste gedrückt so gilt Einstellung A.
1 MOhm - 15 pF (X6)	BNC-Eingangsbuchse für externes Triggersignal.

3.3.5. Elektronenstrahlröhre Bildteil

INTENS/POWER ON	Netzschalter ON/OFF: Wenn das Gerät eingeschaltet ist leuchtet die LED-Anzeige. Bei Betriebsart (MAX) WRITE, FAST oder MEMORY OFF: die Stellung des Knopfes bestimmt die Leuchtdichte der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform. Bei Betriebsart STORE: Die Stellung des Knopfes bestimmt die Helligkeit der dargestellten Signalform auf dem Bildschirm. Bei erhöhter Helligkeit vermindert die Speicherzeit.
STORE/WRITE/FAST/ERASE	Drucktastenschalter für die Einstellung des Speichersystems.
STORE	Gestattet Speicherung registrierter Signalformen über längere Zeit. Steller INTENS ist wirksam.
WRITE	Gestattet Registrierung der Signalform bei normaler Schreibgeschwindigkeit. Steller PERSISTENCE und INTENS sind wirksam.
FAST	Gestattet Registrierung der Signalform bei hoher Schreibgeschwindigkeit. Die Steller VIEW TIME und INTENS sind wirksam.
ERASE	Zur Löschung der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform. Dieses Bedienelement ist nicht wirksam bei Betriebsart STORE.
MEMORY OFF	Wenn die Drucktasten STORE und WRITE gemeinsam gedrückt werden, wird die Speicherfunktion der Elektronenstrahlröhre ausgeschaltet.

Das Gerät arbeitet in STORE wenn eine falsche Tastenkombination gewählt ist.

PERSISTENCE/VIEW TIME	Mit diesem Steller wird ein variables Festhalten der geschriebenen Signalform bewirkt (variable Nachleuchtdauer). In Stellung MAX wird die Schreibgeschwindigkeit etwa um einen Faktor 10 erhöht. Die Elektronenstrahlröhre zeigt einige Hintergrundbeleuchtung. Bei Betriebsart FAST erfolgt automatische Löschung und Aufzeichnung eines neuen Bildes nach einer gewissen Zeit. Diese Zeit wird von der Stellung des Knopfs VIEW TIME betimmt. Wenn dieser Knopf auf MAX steht erfolgt die Aufzeichnung eines neuen Bildes nur nachdem Taste ERASE eingedrückt ist. Die Elektronenstrahlröhre zeigt jetzt einige Hintergrundbeleuchtung.
VAR/MAX WRITING SPEED (S27, R20, Rückwand)	Schalter S27 ermöglicht selektion zwischen maximale Schreibgeschwindigkeit mit Hintergrundbeleuchtung oder niedrigere Schreibgeschwindigkeit ohne Hintergrundbeleuchtung (einstellbar mittels Schraubenzieher—einstellung R20)

FOCUS

Stufenlose Einstellung der Elektronenstrahl-Fokussierung in horizontaler Richtung. Die vertikale Fokussierung wird vom Steller INTENSity beeinflusst. Deshalb bleibt die vertikale Fokussierung beinahe über den gesamten Leuchtdichtebereich eingestellt. Die äussersten Stellungen des Stellers INTENS sind mit Hilfe eines Potentiometers, welches durch ein Belüftungsloch in der linken Seite des Geräts zugänglich sind, einstellbar.
Die höchste Schreibgeschwindigkeit bei Betriebsart FAST wird nur dann erreicht wenn die Fokussierung des Elektronenstrahls optimal ist.

TRACE ROT (R15)

Voreinstellung zur Ausrichtung der Leuchtspur mit den Rasterlinien.
Schraubenziehereinstellung, zugänglich durch ein Belüftungsloch in der linken Seite des Geräts.

3.3.6. Verschiedenes

CAL (X1, X2)

Ausgangsbuchse an der eine Rechteckspannung von 3 V_{ss} und ein Strom von 6 mA mit einer Frequenz von 2 kHz für Kalibrierung zur Verfügung steht.

⏚ (X5)

Messerde

Z-MOD (X8) an Rückseite

Eingangsbuchse für externe Z-Modulation.

3.4. VORBEREITENDE EINSTELLUNGEN

Da die folgenden Einstellungen für beide vertikale Kanäle gleich sind, ist nur die Vorschrift für Kanal A gegeben. Falls nich anders erwähnt sind die Bedienungsorgane in den gleichen Stellungen wie in vorgehender Einstellvorschrift.

3.4.1. Verstärkungseinstellung

- Drucktaste AUTO des Triggerart-Wahlschalters (S8) betätigen.
- Drucktaste A des Darstellungsartenschalters betätigen (S1).
- Drucktaste MAIN TB des Horizontalablenkungsschalters betätigen (S2).
- Bild(er) mit Hilfe der entsprechenden Einsteller POSITION entrieren.
- Mit Einstellern INTENS und FOCUS die Bildschärfe regeln.
  Nicht erwähnte Einstellorgane dürfen in jeder beliebigen Stellung stehen.
- Schalter AC-0-DC in Stellung DC.
- Schalter AMPL im Stellung 0,5 V und stufenlosen Einsteller in Stellung CAL.
- Buchse CAL mit Eingangsbuchse A verbinden.
- Prüfen ob die Bildhöhe genau 6 Teile beträgt.
  Nötigenfalls Steller GAIN auf der Frontplatte direkt unter dem Schalter GAIN neu einstellen.

3.5. EINGÄNGE A UND B UND IHRE MÖGLICHKEITEN

Der Oszillograf besitzt zwei identische Kanäle, die entweder zusammen mit einem oder beiden Zeitablenkgeneratoren für YT Messungen, oder aber zusammen mit dem externen Horizontalkanal für XY Messungen verwendet werden können.

3.5.1. YT-Messungen

Zur Darstellung eines Signals ist einer der beiden Vertikalkanäle mit Taste A oder Taste B der Darstellungsartenschalter zu wählen.
Wird Taste ALT oder CHOP gedrückt, können zwei verschiedene Signale gleichzeitig abgebildet werden. Der Y-Ablenkkoeffizient und die Polarität können für jeden Kanal getrennt gewählt werden. Wird Taste ALT betätigt dann wird die Darstellung beim Rücklauf des Zeitablenksignals von einem Kanal auf den anderen umgeschaltet. Obwohl Stellung ALT für alle Ablenkzeiten verwendet werden kann, ergibt für lange Ablenkzeiten Stellung CHOPPED eine bessere Bildgüte, da das abwechselnde Darstellen der beiden Eingangssignale während dieser langen Ablenkzeiten deutlicher sichtbar ist.

In Stellung CHOPPED wird die Darstellung mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet.
In Stellung ADDED des Darstellungsartenschalters werden die Signalspannungen der beiden vertikalen Kanäle addiert. Abhängig von der Stellung der Polaritätsschalter wird entweder die Summe oder die Differenz der Eingangssignale dargestellt. Die Einstellung ADDED ermöglicht auch Differenzmessungen. Bei diesen Messungen wird die Gleichtaktunterdrückung der Stellung ADDED ausgenützt. Wenn die Polaritätsschalter beider Kanäle in entgegengesetzten Stellungen stehen, werden die Gleichtaktteile der Signale von Kanal A und B im Verhältnis zu den Gegentaktteilen nur sehr geringfügig verstärkt.

3.5.2. XY-Messungen

Wenn Drucktaste EXT X DEFL (S2) des Horizontalablenkungsschalters und einer des TRIG OR X DEFL-Schalters eingedrückt sind ist der Zeitablenkgenerator ausgeschaltet. Wenn beispielsweise Drucktaste A von S22 eingedrückt ist ein Signal das über Kanal A zugeführt wird kann nur zur Horizontalablenkung verwendet werden. Der Schalter AC/0/DC und der Stufenabschwächer von Kanal A bleiben wirksam.
Mit dem Einsteller X POSITION wird horizontale Bildverschiebung ermöglicht und mittels A AMPL/DIV kontinuierliche Einstellung des Ablenkkoeffizienten.

Für X Ablenkung kann auch der vertikale Kanal B verwendet werden.
In diesem Fall Taste B des TRIG OR X DEFL-Schalters eindrücken.

Es ist ferner möglich eine interne Spannung der Netzfrequenz, oder ein Signal angelegt an die EXT Buchse (Vorderseite rechts unten), für die X-Ablenkung zu verwenden. Zu diesem Zweck die betreffende Drucktaste des TRIG OR X DEFL-Schalters eindrücken.
In EXT und EXT ÷ 10 Betriebsarten kann die Bildbreite mit dem X AMPL/HOLD OFF Potentiometer eingestellt werden. Mit diesem Potentiometer in Stellung CAL, beträgt der Ablenkungskoeffizient für externe Signale 50 mV/Teil. Das externe Signal lässt sich durch Eindrücken der DC oder LF Taste der Triggerkopplungseinsteller der Hauptzeitablenkung entweder gleichspannungs- oder wechselspannungskoppeln (untere Frequenzgrenze 10 Hz).

3.5.3. AC/0/DC Schalter

Die zu beobachtenden Signale sind an die Buchse(n) A und/oder B zu legen und der AC/0/DC Schalter abhängig von der Zusammensetzung der Signale auf AC oder DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.
Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein, Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechselspannungskomponenten. In diesem Falle ist der Eingangsschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungs- und Niederfrequenz- Signale unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen.
Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

3.6. TRIGGERUNG

Wenn ein Signal dargestellt werden soll, muss, um ein stillstehendes Bild zu erhalten, die Horizontalablenkung stets an einem festen Punkt des Signals gestartet werden.
Der Zeitablenkgenerator wird folglich von in der Triggereinheit erzeugten schmalen Triggerimpulsen gestartet und durch ein Signal gesteuert das entweder den vertikalen Eingangssignalen, einer internen Netzfrequenzspannung oder einer externen Quelle entstammen kann.

3.6.1. Triggerkopplung

Mit Schalter DC/LF/HF kann man drei verschiedene Triggerkopplungsarten wählen. In den Stellungen HF und LF ist die Übertragungscharakteristik begrenzt.
In Stellung DC wird das Triggersignal unverändert durchgelassen.
In Stellung LF wird ein 0 Hz (7Hz bei externer Triggerung) bis 30 kHz Bandpass eingesetzt. Diese Stellung dient zur Verminderung von Störungen durch Rauschen.
In Stellung HF wird ein 30 kHz Hochpass eingesetzt. Diese Stellung kann zum Herabsetzen von Störungen durch Brummen verwendet werden.

3.6.2. Selektieren der Triggerquelle und Einstellen des Triggerpegels

Das Triggersignal kann von Kanal A (Taste A gedrückt), Kanal B (Taste B gedrückt), den COMP A und B Signalen (Tasten A und B gleichzeitig eingedrückt), von einer externen Quelle (Taste EXT oder EXT ÷ 10 gedrückt) oder von einer internen Spannung bei Netzfrequenz (Tasten EXT und EXT ÷ 10 gleichzeitig eingedrückt) entnommen werden.
Der Triggerimpulsformer ist ein zweifach gesteuerter Multivibrator, der von den Ausgangssignalen eines Differenzverstärkers gesteuert wird.
Das Triggersignal wird zusammen mit Vorspannungen die mit Potentiometer LEVEL einstellbar sind an die Eingänge des Differenzverstärkers gelegt.

Abhängig von der LEVEL Einstellung wird ein bestimmter Teil des Triggersignals durch den Differenzverstärker verstärkt.
Der Multivibrator ist somit auf einen fasten Punkt des Triggersignals geschaltet (Abb. 2.4.). Das bedeutet, dass es mit Hilfe des Einstellers LEVEL möglich ist die Form des Triggersignals abzutasten (bei interner Triggerung A oder B gleich der Form des darzustellenden Signals) und somit den Punkt zu wählen, an dem der Multivibrator umgeschaltet wird.
Der Potentiometer ist mit einem Zug-Druck-Schalter versehen, der die Wahl der Triggerflanke erlaubt.

3.6.3. Automatische Triggerung

Wenn Taste AUTO des AUTO-TRIG-SINGLE-Schalters gedrückt ist - und wenn keine Triggerimpulse vorhanden sind - ist der Zeitablenkgenerator automatisch freilaufend. Das Bild ist daher stets sichtbar. Die Stellung AUTO kann in allen Fällen verwendet werden in welchen auch Stellung TRIG anwendbar ist, ausgenommen bei Signalfrequenzen niedriger als 10 Hz oder Impulsreihen mit der "AUS"-Zeit über 100 ms.
Sobald Triggerimpulse vorhanden sind, wird der Freilauf des Zeitablenkgenerators automatisch beendet und der Zeitablenkgenerator erneut getriggert wie erwähnt in Abschnitt 2.2.4.1. und 2.2.4.2.
Wird Taste TRIG oder Taste SINGLE eingedrückt ist die Automatik ausgeschaltet. Einstellung LEVEL kann auch in Betriebsart AUTO benutzt werden.

3.6.4. SINGLE-SWEEP-Triggerung

Wenn einmalige Vorgänge beobachtet (und in der Regel fotografiert) werden müssen, ist es oft wünschenswert dafür zu sorgen, dass nur ein Sägezahn erzeugt wird, selbst wenn möglicherweise nach Darstellung dieses Vorgangs mehrere Triggerimpulse erzeugt würden. Selbstverständlich muss der betreffende einzelne Sägezahn von einem Triggerimpuls getriggerd werden. Zu diesem Zweck Taste SINGLE eindrücken. Der erste Triggerimpuls , der nach Loslassen der gedrückten Taste erscheint, startet den Zeitablenkgenerator.
Der Zeitablenkgenerator wird dann blockiert bis Taste SINGLE wieder betätigt wird. Die Lampe NOT TRIG'D leuchtet auf sobald die Taste SINGLE eingedrückt ist, und bleibt leuchten bis der Triggerimpuls ankommt.

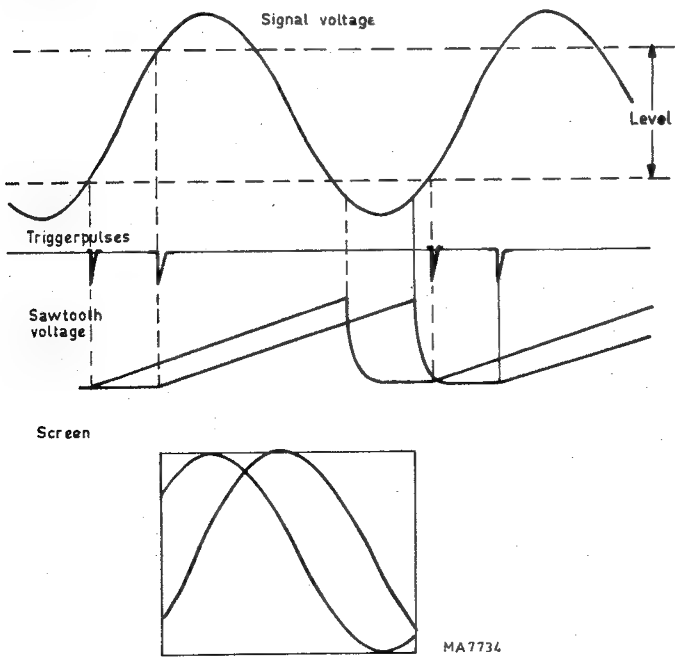


Abb. 3.2. Abtasten der Wellenform mittels des LEVEL Potentiometers

3.7. DEHNUNG DER ZEITABLENKUNG MAGN (R2/S3)

Die Dehnung der Zeitablenkung wird mit einem Zug-Druck-Schalter der an den Einsteller für horizontale POSITION gekoppelt ist, eingestellt. Wenn dieser Schalter in Stellung X10 gezogen ist wird ein 10 mal schnellerer Zeitmassstab des Hauptzeitablenkgenerators eingestellt. Folglich wird der Signalteil, welcher in der X1 Stellung (TB MAGN eingedrückt) über eine Breite von ein Teil (DIV) in der Schirmmitte dargestellt wird, in der X10 Stellung über die Gesamtbreite des Schirmes geschrieben.
Jeder Teil des Bildes kann mit dem horizontalen POSITION Einsteller zur genauen Beobachtung sichtbar gemacht werden.
In der X10 Stellung wird der Zeitkoeffizient durch Teilen des gegebenen Wertes TIME/DIV durch 10 ermittelt.

3.8. GEBRAUCH DER VERZOGERTEN ZEITABLENKUNG DTB

Die verzögerte Zeitablenkung kann zur genauen Beobachtung komplexer Signale verwendet werden. Sofort nach betätigung der Drucktaste MAIN TB der Triggerquelleneinsteller (S21) der verzögerten Zeitablenkung wird ein Teil des dargestellten Signals in Stellung MAIN TB des Horizontal-Ablenkungsschalters (S21) zusätzlich aufgehellt. Mit dem DELAY TIME Einsteller (R1) ist dieser zusätzlich aufgehellte Teile über die Zeitachse verschiebbar. Die Zeitdauer dieses zusätzlich aufgehellten Teils ist mit den Einstellern TIME/DIV des verzögerten Zeitablenkgenerators sowohl stufenweise wie stufenlos einstellbar. Mit Drucktaste DEL'D TB des Horizontalablenkungs-Schalters (S2) wird der zusätzlich aufgehellte Teil über die gesamte Schirmbreite sichtbar gemacht. In Stellung DEL'D TB, wird die Verzögerungszeit (dass heisst die Zeit zwischen dem Startpunkt der Hauptzeitablenkung und dem Startpunkt der verzögerten Zeitablenkung) bestimmt durch die Einstellungen des Schalters TIME/DIV der Hauptzeitablenkung und die des DELAY TIME Einstellers.
Wenn einer der Schalter der verzögerten Zeitablenk-Triggerquelle (S21) betätigt, dann startet der erste Impuls nach der gewählten Verzögerungszeit die verzögerte Zeitablenkung. Dieser Triggerimpuls wird von der Triggereinheit des verzögerten Zeitablenkgenerators geliefert.
Diese Stellung kommt zur Anwendung wenn durch Jitter eine undeutliche Darstellung zu beobachten ist. Dieses Jitter kann durch das beobachtende Signal selbst oder durch externe Dehnung in den Zeitablenkschaltungen entstehen.

3.9. GEBRAUCH DER ALTERNIERENDEN ZEITABLENKUNG ALT TB

Das PM 3266 ist mit Darstellungsumschaltung ausgerüstet. Diese Vorrichtung bietet dem Gebraucher gleichzeitige Darstellung des Signals an den beiden von der Hauptzeitablenkung und von der verzögerten Zeitablenkung zur Verfügung gestellten Zeitmassstäben.
Genauere Beobachtung eines bestimmten Abschnitts der Hauptzeitbasis-Darstellung wird durch Erweiterung des betreffenden Zeitintervalls mit Hilfe der verzögerten Zeitbasis ermöglicht. Durch Wahl einer entsprechend schnelleren Ablenkung für TIME/DIV der verzögerten Zeitbasis wird die Erweiterung erzielt. Mit Potentiometer DELAY TIME lässt sich die Positionierung des Zeitintervalls einstellen.
Der von der verzögerten Zeitbasis ausführlich zu beobachtende Teil des Signals bleibt ein aufgehellter Bildausschnitt der Hauptzeitbasis. Dies erleichtert nicht nur die Lokalisierung des gewünschten Details, wenn der Skalenpotentiometer (R1) gedreht wird, sondern dient auch als Sichtanzeige des zu betrachtenden Ausschnitts des Gesamtbildes. Mann kann auch sofort das Detail mit dem Signal, welches sehr complex sein kann, in Beziehung bringen, ohne dabei zwischen MAIN TB und DEL'D TB schalten zu müssen.
Mit TRACE SEP ist die Vertikalverschiebung zwischen den beiden Zeitbasen kontinuierlich einstellbar.

3.10. GEBRAUCH DES DRITTEN KANAL TRIGGER VIEW

3.10.1. Externe oder interne Triggerung

Bei zahlreichen Anwendungen, wie bei Triggerung mit digitalen Signalen oder mit Signalen von sehr unterschiedlichen Formen ist Anwendung einer externen Triggerquelle erforderlich damit eine einwandfreie Zeitbeziehung gewährleistet ist und um die Zeitbeziehung zwischen Triggersignal und Messsignal(en) zu kennen.
Durch Eindrücken der Taste TRIG VIEW wird das an Eingangsbuchse X7 gelegte externe Triggersignal als dritter Kanal dargestellt, mit der Schwelle nahe der horizontalen mittleren Rasterlinie. Durch Einstellung von LEVEL CONTROL (R7, S7) lässt sich leicht feststellen welcher Teil des Triggersignals die Ablenkung auslöst.
Dies ist auch möglich bei intern von Kanal A oder Kanal B entnommen Signalen wenn Taste A oder B des Schalters S22 gedrückt ist.
Die Empfindlichkeitseinstellung der externen Triggerdarstellungsart hat zwei Stufen, 50 mV/Teil und 0,5 V/Teil.
Mit Drucktastenschalter EXT (S22) eingedrückt ist der Ablenkfaktor 100 mV/Teil und somit ECL kompatibel.
Bei Betriebsart EXT/10 (S22) ist der Ablenkfaktor 1 V/Teil und somit TTL kompatibel.

3.10.2. Einmalige Ablenkung

Mit Hilfe von LEVEL/SLOPE (R7, S7) lässt sich der Triggerpegel auf einen vorbestimmten Wert einstellen ohne dass ein Eingangssignal erforderlich wäre. Dies ist von Bedeutung wenn das zu messende Signal nicht im voraus vorhanden ist, wie beispielsweise bei der Prüfung von einzelner Vorgänge. Wenn Eingangssignale, die eine bekannte Schwelle überschreiten, dargestellt werden sollen, kann der Triggerpegel LEVEL CONTROL (R7, S7) im voraus eingestellt werden und ein Eingangssignal genügender Amplitude wird die Zeitablenkung auslösen.
Einstellung des Triggerpegels geschieht auf folgende Weise: Drucktaste TRIG VIEW eindrücken.
Das Bild mit Steller LEVEL (R7) soviele Teile in entgegengesetzter Richtung verlagern (bezogen auf die horizontale mittlere Rasterlinie) wie die Triggerschwelle erfordert.

Bemerkung: Die Triggerquelle ist definiert als der Abstand zwischen Triggerpunkt und Nullinie des Verstärkers (d.h. ohne Eingangssignale und ohne Ablenkung mittels Steller POSITION).

3.11. BEDIENUNG DER SPEICHERFUNKTIONEN

MEMORY OFF Betrieb

Wenn die Tasten STORE und WRITE gedrückt sind, ist die Speicherfunktion ausgeschaltet und arbeitet das Gerät als ein normales Oszilloskop. Mit dem Knopf INTENS wird die Helligkeit der dargestellten Signalform geregelt. Der Knopf FOCUS muss auf die maximale Schärfe der dargestellten Signalform eingestellt werden.

Sperren des Speichersystems. Wenn das Gerät in Betriebsart FAST (nach Ende des ERASE Zyklus) auf die Zeitablenkung wartet, kann das Gerät nur auf MEMORY OFF Betrieb gestellt werden und nicht auf WRITE oder STORE Betrieb Einstellung auf WRITE oder STORE Betrieb wenn beim FAST Betrieb der gesamte ERASE/WRITE Betrieb-Zyklus beendet ist; mit anderen Worten nur nach Ablauf der Zeitbasis und nachdem das Bild übertragen wurde.

ACHTUNG: Eine grosse Helligkeit über längere Zeit, vor allem im Betriebsart MEMORY OFF, kann die Elektronenstrahlröhre beschädigen.

WRITE Betrieb

Die Signalform wird mit normaler Geschwindigkeit geschrieben. Die Stellung des Knopfes INTENS bestimmt die Helligkeit der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform. Je nach Stellung des Knopfes PERSISTENCE wird entweder ein rasch verschwindendes Bild auf grünem Untergrund geschrieben (Steller gänzlich nach links gedreht) oder ein langsam verschwindende Leuchtspur auf schwarzem Untergrund (Steller berührt den ersten rechtsläufigen Anschlag). Bei Darstellung eines Niederfrequenzsignals kann PERSISTENCE so eingestellt werden, dass ein Flimmern des Bildes unterdrückt wird.
Bei einem signal mit niedriger Folgefrequenz und kurzer Anstiegszeit kann PERSISTENCE so eingestellt werden, dass die Schreibspur aufgefüllt wird damit eine deutliche und stabile Darstellung erzielt wird.
Die Schreibgeschwindigkeit lässt sich um einen Faktor von etwa 10 erhöhen wenn PERSISTENCE auf MAX gestellt wird.

FAST Betrieb

Die Signalform wird mit hoher Schreibgeschwindigkeit aufgezeichnet. Die Stellung des Knopfes INTENS bestimmt die Helligkeit der auf der Speicherschicht der Elektronenstrahlröhre geschriebenen Signalform.
Diese Betriebsart ist ein Einmalbetrieb. Falls VIEW TIME nicht auf MAX steht wird der nächste Zyklus wiederholend ausgeführt. Das gespeicherte Bild wird gelöscht und danach wird, sobald die Zeitbasis getriggert ist, ein neues Bild geschrieben. Nach einer einstellbaren Betrachtungszeit beginnt der nächste Zyklus mit Löschung des Bildschirms.
Die Betrachtungszeit lässt sich mit Hilfe des Stellers VIEW TIME zwischen 3 Sekunden (Steller ganz nach links gedreht) und 8 Sekunden (Steller berührt den ersten rechtsläufigen Anschlag) einstellen.
Wenn Knopf VIEW TIME in Stellung MAX steht dann wird ein neues Bild erst dann aufgezeichnet wenn Taste ERASE gedrückt wurde. In dieser Betriebsart ist es auch möglich das Gerät nach Ablauf der Zeitbasis und nachdem ein neues Bild geschrieben wurde in STORE-Betriebe arbeiten zu lassen.
Diese Funktion wird auf folgende Weise bewirkt. Das Gerät auf FAST und danach auf ERASE (Löschen des Bildes) stellen. Das Gerät wartet nun auf ein Triggersignal. Jetzt Taste STORE eindrücken und das Gerät wird sich in STORE-Betrieb befinden, nachdem das neue Bild geschrieben wurde. Um eine gute Bildqualität zu erhalten darf die Wartezeit für das Triggersignal nicht länger als 1 Minute dauern.
Wegen der Bildübertragung ist die Betriebsart mit dem schnellen Speichernetz bei langsamen Zeitkoeffizienten weniger geeignet, weil hierbei der bei jeder Horizontalablenkung zuletzt geschriebene Teil des Signals heller als der Anfang wiedergegeben wird.

STORE Betrieb

In dieser Betriebsart kann eine aufgezeichnete Signalform über längere Zeit gespeichert werden. Steller INTENS ist wirksam: wenn der Steller den ersten linksläufigen Anschlag berührt, ergibt dies eine lange Speicherzeit von etwa 1 Stunde. In dieser Stellung ist die Signalform nicht sichtbar. Wenn Steller INTENS ganz nach rechts gedreht ist ergibt dies kurze Speicherzeit. Für Werte siehe Abschnitt "Technische Daten". Die Signalform ist nun deutlich sichtbar. Drucktaste ERASE ist bei STORE-Betrieb nicht wirksam.

ERASE Betrieb

Wird die Strahlspur nicht mehr benötigt, dann kann sie durch Eindrücken der Taste ERASE (nicht wirksam bei STORE-Betrieb) gelöscht werden. Es kann vorkommen, dass die Strahlspur nicht gänzlich verschwindet besonders die mit beträchtlicher Helligkeit geschriebenen Teile. Dies lässt sich durch langzeitige Betätigung der Taste "ERASE" vermeiden.

4. FUNKTIONSPRÜFUNG

4.1. ALLGEMEINE INFORMATION

Bei dieser Prüfung sollen alle wichtigen Funktionen des Oszilloskops mit minimalem Aufwand geprüft werden. Es wird vorausgesetzt, dass die prüfende Person dieses Oszilloskop und seine Daten kennt.

ACHTUNG: **Vor dem Einschalten muss gewährleistet sein, dass der Oszillograph gemäss den Anweisungen in Kapitel 2 installiert wurde.**

Wenn mit dieser Prüfung schon einige Minuten nach dem Einschalten des Geräts begonnen wird, ist zu berücksichtigen, dass wegen der ungenügenden Anwärmzeit einige Daten nicht eingehalten werden. Damit dies nicht geschieht, lassen Sie das Gerät zunächst die vorgeschriebene Zeit vorwärmen. Die Prüfung ist bei Umgebungstemperaturen von 20 ... 30^{o}C auszuführen.
Die zu prüfenden Werte sind ohne Toleranz angegeben und geben die Eigenschaften eines durchschnittlichen Geräts wieder. Für die Toleranzen siehe Abschnitt 1.2. "TECHNISCHE DATEN". Die Prüfungen werden mit Hilfe des eigenen Kalibrierspannungsgenerators des Geräts ausgeführt.

ACHTUNG: **Stellen Sie den Elektronenstrahl nicht heller als nötig ein, damit Sie scharfe und gut ablesbare Bilder erhalten. Durch längeren Betrieb mit grosser Helligkeit kann ausserdem das Speichersystem der Elektronenstrahlröhre beschädigt werden.**

4.2. AUSGANGSSTELLUNG DER BEDIENUNGSORGANE

- MEMORY OFF wählen: die Tasten STORE und WRITE des Speicherwahlschalters S24 drücken.
- Taste AUTO des Triggerwahlschalters S8 drücken.
- Taste ALT des Vertikal-Wahlschalters S1 drücken.
- Die AMPL/DIV-Schalter S9 und S11 von Kanal A und B in Stellung 0,5 V/DIV und ihre Feineinsteller R8/S10 und R9/S12 in Stellung CAL setzen.
- Die POSITION-Einsteller R3/S4 und R4/S5 von Kanal A und B in ihre Mittelstellung drehen und dann drücken.
- Die Kopplungsschalter AC/0/DC S17 und S18 von Kanal A und B in Stellung 0 setzen.
- Schalter TIME/DIV S15 der Hauptzeitbasis in Stellung 0,1 ms/DIV und seinen Feineinsteller R11/S16 in Stellung CAL setzen.
- Schalter TIME/DIV S13 der verzögerten Zeitbasis in Stellung OFF und seinen Feineinsteller R10/S14 in Stellung CAL setzen.
- Taste MAIN TB des Horizontal-Wahlschalters S2 drücken.
- Knopf R2 für die horizontale Position in die Mittelstellung drehen und drücken.
- Die DC-Tasten der Triggerkoppelschalter S19 und S20 der Hauptzeitbasis und der verzögerten Zeitbasis drücken.

4.3. ANZEIGETEIL MIT ELEKTRONENSTRAHLRÖHRE

- Mit den Knöpfen INTENS und FOCUS (R14 und R17) ein deutliches Bild einstellen. Wenn diese Prüfungen durchgeführt werden, kann es erforderlich sein, die Knöpfe nachzustellen.
- Die Zeitbasislinien von Kanal A und Kanal B mit den POSITION-Potentiometern R3, R4 und R2 zentrieren.
- Prüfen, ob die Zeitbasislinien genau parallel zu den horizontalen Rasterlinien verlaufen. Falls nicht, dies mit TRACE ROTATION R15 einstellen. Dieses Schraubenzieherpotentiometer ist durch eine Ventilationsöffnung an der linken Seite des Geräts zugänglich.

4.4. VERTIKAL-KANALE

- Die Prüfung von Kanal A und Kanal B ist identisch. Die Knöpfe, Buchsen und Einsteller von Kanal B stehen hinter denen von Kanal A in Klammern.

- Schalter TIME/DIV der Hauptzeitbasis in Stellung 50 ms/DIV setzen und prüfen, ob Kanal A und B abwechselnd dargestellt werden.
- Taste CHOP des Vertikal-Wahlschalters drücken und prüfen, ob Kanal A und B scheinbar gleichzeitig dargestellt werden.
- Schalter TIME/DIV der Hauptzeitbasis in Stellung 0,1 ms/DIV setzen.
- Taste A (B) des Vertikal-Wahlschalters drücken: nun darf nur die Zeitbasislinie von Kanal A (B) sichtbar sein.
- Taste A (B) des Triggerwahlschalters S22 der Hauptzeitbasis drücken.
- Die Spannung von der CAL-Buchse X1/X2 an die Eingangsbuchse X3 (X4) von Kanal A (B) anschliessen.
- Den Kopplungsschalter S17 (S18) von Kanal A (B) in Stellung DC setzen: nun ist das Signal von Buchse CAL auf dem Schirm sichtbar.
- Den Knopf LEVEL der Hauptzeitbasis so einstellen, dass ein stabiles Signal auf dem Schirm geschrieben wird. Die Vertikalablenkung muss 6 Schirmteile betragen. Sollte dies nicht der Fall sein, Potentiometer R12 (R13) mit einem Schraubenzieher neu einstellen.
- Nun die Funktion von Wahlschalter S7 für die Triggerflanke prüfen. Dieser Schalter ist mit dem Knopf LEVEL R7 kombiniert. Wenn R7/S7 herausgezogen ist, muss die Zeitablenkung von der negativen Flanke des Signals ausgelöst werden, bei gedrücktem Knopf dagegen von der positiven Flanke des Signals.
- Das nun dargestellte Signal ist eine Rechteckspannung, die sich von 0 V bis +3 V erstreckt. Die mittlere Gleichspannung dieses Signals beträgt 1,5 V. Wird der Kopplungsschalter AC/0/DC in Stellung AC gesetzt, kommt die Gleichspannungskomponente nicht mehr zur Geltung und das Signal liegt symmetrisch zum 0-V-Pegel auf dem Schirm. Nun die Stellung AC prüfen.
- Prüfen, ob das Signal von Kanal A (B) auf dem Schirm invertiert wird, wenn die Funktion PULL TO INVERT durch Herausziehen von Knopf POSITION S4/R3 (S5/R4) eingeschaltet wird.
- Den Knopf POSITION von Kanal A (B) wieder hineindrücken.

- Taste EXT X DEFL des Horizontal-Wahlschalters drücken.
- Taste A (B) des Triggerwahlschalters der Hauptzeitablenkung drücken.
- Die Spannung von der CAL-Buchse an die Eingangsbuchse von Kanal A (B) anschliessen.
- Taste B (A) des Vertikal-Wahlschalters drücken.
- Prüfen, ob zwei Punkte in einem horizontalen Abstand von 6 Schirmteilen dargestellt werden.

- Taste TRIG VIEW des Vertikal-Wahlschalters drücken.
- Taste A (B) des Triggerwahlschalters der Hauptzeitbasis drücken.
- Die Spannung von der CAL-Buchse an die Eingangsbuchse von Kanal A (B) anschliessen.
- Taste MAIN TB des Horizontal-Wahlschalters drücken.
- Prüfen, ob auf dem Schirm ein Rechtecksignal von 6 Schirmteilen dargestellt wird. Dieses Signal muss vertikal verschoben werden, wenn der Knopf LEVEL der Hauptzeitbasis gedreht wird.

4.5. ZEITBASEN UND TRIGGERUNG

- Taste A (B) des Vertikal-Wahlschalters drücken.
- Das Signal von der CAL-Buchse an die Eingangsbuchse von Kanal A (B) anschliessen.
- Taste A (B) des Triggerwahlschalters der Hauptzeitbasis drücken.
- Schalter TIME/DIV der Hauptzeitbasis in Stellung 0,1 ms/DIV setzen.
- Taste MAIN TB des Horizontal-Wahlschalters drücken.
- Mit dem Knopf LEVEL der Hauptzeitbasis ein getriggertes Schirmbild einstellen.
- Den Knopf TB MAGN R2/S3, der mit dem Potentiometer für die Horizontalverschiebung kombiniert ist, herausziehen und prüfen, ob die Horizontalablenkung mit dem Faktor 10 gedehnt wird.
- Den Knopf TB MAGN wieder hineindrücken.
- Taste SINGLE des Triggerwahlschalters S8 drücken. Prüfen, ob nach dem Loslassen dieser Taste die Hauptzeitbasis nur einmal über den Schirm läuft.
- Wieder Taste AUTO des Triggerwahlschalters drücken.
- Den Schalter TIME/DIV S13 der verzögerten Zeitbasis in die Stellung 20 μs/DIV und den Feineinstellknopf R10/S14 in Stellung CAL setzen.
- Taste MAIN TB des Triggerwahlschalters S21 der verzögerten Zeitablenkung drücken.
- Prüfen, ob beim Signal der Hauptzeitbasis ein aufgehellter Teil sichtbar wird und ob dieser Teil mit Hilfe des Knopfes DELAY TIME R1 auf der Hauptzeitbasislinie verschoben werden kann.

Falls erforderlich, den Knopf INTENS so einstellen, dass der aufgehellte Teil des Signals der Hauptzeitbasis gut zu erkennen ist.

- Taste DELD TB des Horizontal-Wahlschalters drücken und prüfen, ob der aufgehellte Teil nun die ganze horizontale Schirmbreite einnimmt.
- Taste ALT TB des Horizontal-Wahlschalters drücken. Nun müssen sowohl das Signal der Hauptzeitbasis mit dem aufgehellten Teil als auch der aufgehellte Teil, der über die gesamte horizontale Schirmbreite geschrieben wird, dargestellt werden. Die Vertikalverschiebung zwischen den beiden Kurven muss sich mit dem Knopf TRACE SEP R6 einstellen lassen.

- Taste MAIN TB des Horizontal-Wahlschalters drücken.
- Taste A (B) des Triggerwahlschalters der verzögerten Zeitbasis drücken.
- Den Knopf LEVEL R5 der verzögerten Zeitbasis so einstellen, dass der aufgehellte Teil in dem Signal der Hauptzeitbasis sichtbar ist. Ausserdem die Funktion des Triggerflankenschalters SLOPE S6 prüfen, der mit dem Knopf LEVEL kombiniert ist.

4.6. SPEICHERFUNKTIONEN

- Taste A des Vertikal-Wahlschalters drücken.
- Die Spannung von Buchse CAL an die Eingangsbuchse von Kanal A anschliessen.
- Schalter TIME/DIV der verzögerten Zeitbasis in Stellung OFF setzen.
- Taste A des Triggerwahlschalters der Hauptzeitbasis drücken.
- Taste MAIN TB des Horizontal-Wahlschalters S2 drücken.
- Den Knopf LEVEL der Hauptzeitbasis so einstellen, dass das Bild auf dem Schirm getriggert wird.
- Taste SINGLE des Triggerwahlschalters drücken.

- Knopf PERSISTENCE R16/S26 an den linken Anschlag drehen.
- Taste WRITE des Speicherwahlschalters S24 drücken: der ganze Schirm muss nun leicht grün aufleuchten (Hintergrundbeleuchtung).
- Wird Taste ERASE S25 gedrückt, dann wird ein Signal eingeschrieben; die Nachleuchtdauer dieses Signals muss ansteigen, wenn der Knopf PERSISTENCE rechtsherum bis zum ersten Anschlag gedreht wird. Gleichzeitig muss die Hintergrundbeleuchtung abnehmen.
- Knopf PERSISTENCE in Stellung MAX drehen: nun muss etwas Hintergrundbeleuchtung sichtbar werden.
- Ein Signal einschreiben und Taste STORE des Speicherwahlschalters drücken.
  Prüfen, ob bei dieser Betriebsart die Helligkeit des Signals mit dem Knopf INTENS eingestellt werden kann.

- Taste FAST des Speicherwahlschalters drücken und prüfen, ob ein Signal eingeschrieben werden kann. Ein Signal wird nach Betätigung der ERASE-Taste eingeschrieben, wenn der Knopf VIEW TIME R16/S26 in seiner Maximalstellung steht.
- Den Knopf VIEW TIME aus der Maximalstellung herausdrehen. Nun wird der Lösch- und Einschreibzyklus automatisch eingeleitet, mit einem einstellbaren Intervall zwischen den Zyklen: die Intervalle müssen kurz sein, wenn Knopf VIEW TIME am linken Anschlag steht, und sie müssen länger werden, wenn der Knopf rechtsherum bis zum ersten Anschlag gedreht wird.

5. VORBEUGENDE WARTUNG

5.1. ALLGEMEINES

Das Gerät erfordert im allgemeinen keine Wartung, das es keine dem Verschleiss ausgesetzte Bauteile enthält. Um jedoch verlässlichen und fehlerlosen Betrieb zu gewährleisten ist das Gerät vor Feuchtigkeit, Hitze, Korrosion begünstigenden Einflüssen und übermässigem Staub zu schützen.

5.2. REINIGEN DER NEXTEL LACK OBERFLÄCHE

WARNUNG: Der Nextel-Lack ist äthanolbeständig, jedoch nicht gegen Alkohol oder Methylalkohol (Brennspiritus) welcher die Oberfläche angreift (durch eine der denaturierenden Substanzen).

Das glänzende Aussehen der Nextel Lackierung des Gehäuses kann sich im Laufe der Zeit, als Folge von Verschmutzung, verschlechtern. Saubermachen mit einem in Wasser, Äthanol oder einem der üblichen Haushaltswaschmittel getränktem Tuch kann nicht immer den Glanz wiederherstellen und lässt Schmutzreste in Löchern und Poren zurück.

Die 3M Company hat einen neuartigen Putzlappen entwickelt ("White Cleansing Pad", Katalognummer 8440) der getränkt in Wasser, Äthanol oder in ein gewöhnliches Haushaltswaschmittel auch in Löcher und Poren eindringt.

Diese Methode ähnelt der von Scheuerlappen jedoch ohne deren kratzende Wirkung.
Scheuernde Lappen dürfen nicht verwendet werden, da sie die Oberfläche zerkratzen.

5.3. NEUKALIBRIERUNG

Erfahrungsgemäss ist zu erwarten dass das Oszilloskop innerhalb von 1000 Betriebsstunden oder 6 Monaten bei fallweisem Betrieb seiner Spezifikationen arbeitet.
Ausserdem kann Ersetzen von Bauteilen eine Neukalibrierung der betreffenden Schaltung erforderlich machen.
Das Prüf und Einstell Verfahren kann auch bei der Ermittlung gewisser Fehler im Gerät behilflich sein.
In manchen Fällen werden geringfügige Fehler durch Neukalibrierung ermittelt und behoben. Vollständige Prüf- und Einstellanleitungen sind Abschnitt "Prüfung & Einstellung" zu entnehmen.

Notice d'emploi

1. GENERALITES

1.1. INTRODUCTION

L'oscilloscope PM 3266 est du type portatif à grande vitesse d'écriture (1000 DIV/μs). Il permet de mesurer des signaux à haute sensibilité (2 mV/DIV) sur une largeur de bande étendue (100 MHz). L'oscilloscope est équipé de nombreux circuits intégrés qui garantissent un fonctionnement très stable et réduisent le nombre des points de réglage.

En vue du contrôle et du réglage, des points de test sont prévus en certaines positions appropriées autour du circuit. L'appareil présente plusieurs fonctions de mémorisation telles que vitesse d'écriture normale et rapide ainsi que l'effaçage automatique.

Un grand choix de modes d'affichage est possible: voie simple, deux voies alternées ou découpées, deux voies additionnées, en position normale et inversée pour un signal d'entrée et base de temps principale et retardée.

De plus, le PM 3266 présente une troisième voie TRIG VIEW et des possibilités de base de temps alternée.

TRIG VIEW permet l'affichage du signal de déclenchement (interne ou externe) par une troisième voie par l'intermédiaire d'un bouton-poussoir.

ALT.TB offre à l'utilisateur un affichage simultané du signal sur les deux échelles de temps par les bases de temps principale et retardée.

L'oscilloscope se caractérise par une alimentation à faible dissipation.

Cette unité d'alimentation fonctionne pour deux gammes de tension100 V à 127 V et 220 V à 240 V; un commutateur permet ce changement, de sorte qu'il n'est pas nécessaire d'adapter l'appareil à la tension secteur locale.

Toutes ces caractéristiques donnent au présent oscilloscope une grande variétés d'application.

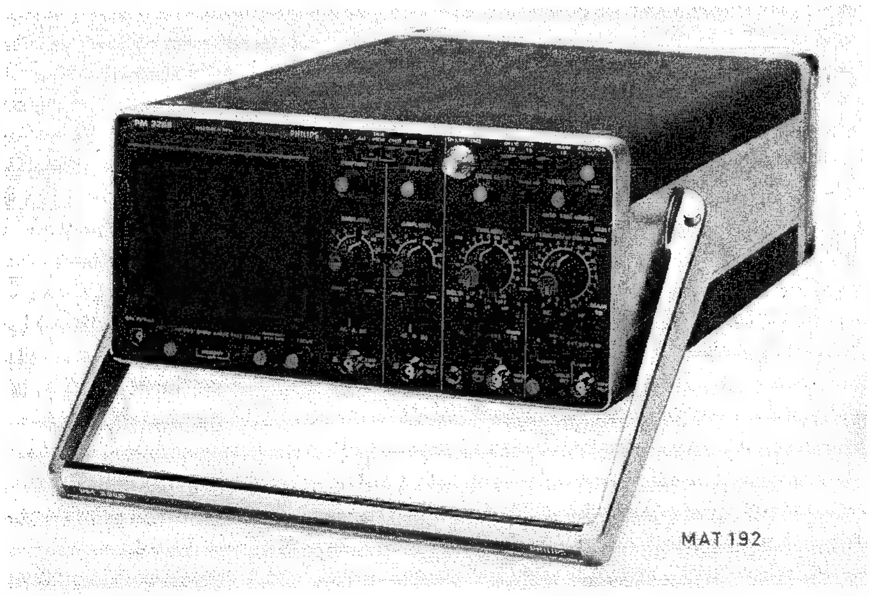


Fig. 1.1. Oscilloscope portatif double trace à mémoire PM 3266

1.2. CARACTERISTIQUES TECHNIQUES

Cet instrument a été conçu et testé conformément à la norme C.E.I. 348 pour des appareils de classe I.
A la livraison, il répond aux règles de sécurité. La présente notice comporte des informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'instrument dans les conditions de sécurité requises et de le maintenir dans un état conforme à la norme.

- *Toutes les spécifications sont valables après un temps d'échauffement* de 30 minutes (température de réference 23^oC) et sans modifier la position de l'appareil.
- Seules les valeurs accompagnées d'une tolérance ou d'une limite sont garanties; les caractéristiques sans tolérance sont données à titre indicatif.
- Les précisions (absolues ou en %) se rapportent à la valeur de réference indiquée.

Désignation	Spécification	Information supplémentaire
1.2.1. Tube à rayons catodiques		
Type	Philips L14-140GH/95	Tube à mémoire à grande vitesse d'ecriture, transfert l'image et agrandissement du balayage en sens vertical. Tube à face rectangulaire, post-accérateur couche phosphore doublée de métal.
Aire de mesure	8x10 div.	1 div. = 0,9 cm.
Type d'écran	Phosphore P31 (GH)	Les lignes droites verticales et horizontales se situeront dans l'aire centrale 7x9 div. de l'écran.
Tension d'accélération totale	10 kV	
Graticule	Interne	pas illuminé.
Gravures	Pointillés à 1,5 et 6,5 Div. à partir du sommet de l'affichage permettent de verifier le temps de montée.	
Vitesse d'écriture	1000 div/µs	En mode FAST. Pas garantie pour les aires carrées de 2 x 2 divisions dans chaque coin de l'écran.
	2,5 div/µs	En mode WRITE et position MAX
	0,25 div/µs	En mode WRITE
Temps de mémoire	1 heure max	En mode STORE: en fonction de la commande INTENS (luminosité)
	60 sec.	En mode WRITE á intensité maximale.
	15 sec.	En mode MAX. WRITE á intensité maximale.
	15 sec.	En mode FAST à intensité maximale.
Persistance	0,3 sec ... 1 min	Fonctionnel en mode WRITE Continûment variable.

Effacement automatique	Fonctionnel en mode FAST avec commande VIEW TIME hors position MAX. Temps de visualisation continûment variable entre 3 et 8 sec.	En mode d'effacement automatique le cycle suivant est réalisé: l'image mémorisée est effacée. Si la base de temps est déclenchée, une nouveau cycle démarre et l'image est effacée, etc. En mode FAST les boutons AUTO, TRIG et SINGLE sont hors service, leur fonction est reprise par l'unité de mémoire.
Temps d'effacement	1,3 sec en mode WRITE 1,6 sec en mode FAST	Les valeurs indiqées représentent le temps entre le relâchement du bouton ERASE et la fin de ce cycle Le bouton ERASE permet de remettre la base de temps principale à zéro.
Rotation de trace	Réglage par tournevis	Accessible par un des trous de ventilation côté gauche de l'appareil.

1.2.2. Axe vertical ou Y

1.2.2.1. Bande passante (gamme 2 mV exceptée)

Gamme de fréquence	continu à 100 MHz 7 Hz ... 100 MHz	–3 dB largeur de bande en couplage continu –3 dB largeur de bande en couplage alternatif La gamme de fréquence inclut une sonde 10:1 à 20-30 °C.
Temps de montée	3,5 ns	Voir fig. 1.5.
Dépassement	± 4 % crête-à-crête	Sur 6 divisions, +5 - +40 °C

1.2.2.2. Coefficients de déviation

		(pour spécifications en gamme 2 mV, se référer à la section 1.2.2.13.).
	2 mV/DIV ... 5 V/DIV	En 11 positions étalonnées (progression 1-2-5) avec commande continue non-calibrée 1: ⩾ 2,5 par potentiomètre. Indication de non-calibrage par lampe.
Erreur limite	± 3 %	Sauf linéarité du tube à rayons cathodiques.
Tension d'entrée maximale admise	± 400 V 800 V_{CC} en alternatif	Tension continue + tension alternative crête Déviant à des fréquences supérieures à 500 kHz. Voir fig. 1.2.
Déviation maximale sans distortion.	24 divisions	Jusqu'à 35 MHz
Gamme de décalage	16 divisions	8 divisions au-dessus et au-dessous de la ligne horizontale centrale du graticule.

	Désignation	Spécification	Information supplémentaire
1.2.2.3.	*Impédance d'entrée*	1MΩ (± 2%) //≈ 15pF	
	Constante de temps RC d'entrée	22 ms	Commutateur de couplage en position AC.
1.2.2.4.	*Instabilité*		(pour réglage 2 mV/DIV, se référer à 1.2.2.13.).
	Instabilité de trace	0,1 div/heure	Gamme de température 20-40°C
	Saut de trace	0,2 div	Lorsque l'on commute l'atténuateur entre deux positions.
	Saut de trace	0,5 div	Lorsqu'on commute NORM/INVERT
	Dérive de trace	0,2 div	Lorsqu'on tourne l'atténuateur continu 0,4 div en gamme 5 mV.
	Dérive de trace	1 div	En poussant le bouton ADDED 0,4 div en gamme 5 mV. Croissante lorsqu'on tourne l'atténuateur continu.
1.2.2.5.	*Dérive de température à court terme*	Identique à 1.2.2.6.	
1.2.2.6.	*Dérive de température à long terme*	20 μV/°C	Valeur typique
1.2.2.7.	*Retard visible du signal*	Environ 15 ns	
1.2.2.8.	*Modes d'affichage*	Voie + ou — A seulement Voie + ou — B seulement Affichage déclenchement seulement Voies ± A et ± B découpées Voies ± A et ± B alternées Voies ± A et ± B additionnées Affichage déclenchement ± A et ± B découpées ou alternées (affichage 3 voies)	Si l'affichage 3 voies est sélectionné avec l'affichage base de temps alternée, l'ensemble est automatiquement affiché en mode de base de temps intensifiée Se référer à 1.2.2.12. pour specifications complètes de l'affichage déclenchement.
1.2.2.9.	*Fréquence de commutation*	≈ 1 MHz	Temps d'affichage par voie: env. 350 ns
1.2.2.10.	*Diaphonie entre voies*	1 : 500	Jusqu'à 50 MHz 8 divisions d'amplitude du signal sur une voie; diaphonie sur l'autre voie dans les limites du voie, jusqu'à 35 Mc.
1.2.2.11.	*Facteur de réjection en mode commun*	Supérieur à 100 jusqu'à 2 MHz 20 à 50 MHz	En mode +A et –B additionnées signal max. en mode commun: 8 div.

	Désignation	*Spécification*	*Information supplémentaire*
1.2.2.12.	*Affichage déclenchement*		
	Affichage	Signal de déclenchement externe ou interne	
	Coefficient de déviation	Comme verticale	
	Externe	100 mV/div ± 3 %	
	Externe÷ 10	1 V/div ± 5 %	
	Interne	Vertical ± 10 %	
	Point de déclenchement	Centre d'écran ± 0,3 div; couplage continu	
	Aberrations	±10 % crête-à-crête	
	Retard de temps entre entrée verticale et entrée externe	3 ns ± 1 ns	
	Largeur de bande	80 MHz	Valeur typique
1.2.2.13.	*Spécification pour réglage 2 mV/div*		
	a. Coefficient de déviation	2 mV/div	
	Erreur limite	± 5 %	
	b. Réponse		
	Gamme de fréquence	Continu 0 ... 35 MHz	–3 dB
		alternatif 7 Hz ... 35 MHz	–3 dB
	Temps de montée	10 ns	
	Aberration d'impulsion	± 5 % crête-à-crête	
	Facteur de réjection en mode commun	meilleure que 100 à 2 MHz	
	c. Instabilité		
	Instabilité de trace	0,25 div/h	Gamme de température 20-40 °C
	Saut de trace	1 div	Lorsque l'on commute l'atténuateur de 5 à 2 mV
	Saut de trace	2 div	Lorsqu'on actionne le commutateur NORM/INVERT
	Dérive de trace	1 div	Lorsqu'on tourne l'atténuateur continu
	Dérive de trace	1 div	En poussant le bouton ADDED

1.2.3. Axe horizontal ou X

1.2.3.1.	*Modes de représentation*	— Base de temps principale	
		— Base de temps principale intensifée par base de temps retardée	
		— Base de temps retardée	Séparation de trace de 4 divisions possible
		— Base de temps intensifiée et base de temps retardée affichées alternativement	
		— Mode X-Y et X-Y/Y	Déviation X par: — le signal voie A — le signal voie B — le signal appliqué au connecteur EXT de la base de temps principale — la fréquence secteur.

	Désignation	*Spécification*	*Information supplémentaire*
1.2.3.2.	*Dérive horizontale en position X1*	0,2 div/h	La dérive horizontale avec agrandisseur en position X1 ne peut pas excéder 0,1 div/h dans la gamme de température 20-40 °C La même stabilité est requise au démarrage du balayage dont la vitesse est variée, sauf pour les gammes de balayage supérieures (50-100 ns/div).
1.2.3.3.	*Commande de la position horizontale*	± 5,2 div à partir du centre de l'écran	La commande de décadrage horizontal combine le réglage gros et le réglage fin.
1.2.4.	**Base de temps principale**		
1.2.4.1.	*Fonctionnements*	Déclenché Automatique Balayage unique	En automatique, la base de temps est en fonctionnement libre en l'absence de signaux de déclenchement après moins de 0,1 s.
1.2.4.2.	*Vitesses de balayage*	1 s/div ... 50 ns/div	En 23 positions étalonnées (progression 1-2-5) Commande continue non-étalonnée 1 : ⩾ 2,5 entre les échelons par potentiomètre Une lampe indiquant le non-calibrage des deux bases de temps.
1.2.4.3.	*Précision de mesure*	± 2 % ± 3 %	Entre +20 °C et +30 °C Entre + 5 °C et +40 °C Différence de précision de balayage pour toutes 2 divisions est de ± 5% à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
1.2.4.4.	*Expansion*		
	Agrandissement	10x	Commuté, étalonné. L'affichage coïncidant à la ligne de graticule verticale centrale ne peut pas dévier de plus d'une division lors du réglage de l'agrandisseur horizontal de X10 sur X1
	Erreur de coefficient	± 1 % supplémentaire	Premières et dernières 50 ns de 5 ns/div, 10 ns/div et 20 ns/div agrandis ± 5 %
	Coefficient de temps efficace maximal	5 ns/div	
1.2.4.5.	*Temps de blocage variable (hold off)*	Le temps de blocage du balayage peut être augmenté par un facteur 10.	
1.2.5.	**Base de temps retardée**		
1.2.5.1.	*Fonctionnement*	La base de temps retardée est déclenchée par la base de temps principale immédiatement après le temps de retard choisi ou par le signal à examiner après le temps de retard (absence de jitter).	

	Désignation	*Spécification*	*Information supplémentaire*
1.2.5.2.	*Stabilité de comparateur à long terme*	< 2 div pour agrandissement 1000 fois	Avec base de temps principale 1 ms/div et retardée 1 μs/div, un détail de signal sélectionné en mode base de temps retardée ne bougera pas de plus de deux divisions après le pré-chauffage.
1.2.5.3.	*Vitesses de balayage*	0,5 s/DIV ... 50 ns/DIV	En 22 positions étalonnées (progression 1-2-5). Commande continue non-étalonnée 1 : ⩾ 2,5 entre les échelons par potentiomètre. Une lampe indiquant le non-calibrage des deux bases de temps.
1.2.5.4.	*Précision de mesure*	± 2 % ± 3 %	Entre +20 °C et +30 °C Entre + 5 °C et +40 °C Cette précision de balayage, mesurée toutes les deux divisions sur 10 DIV est de 5 %, à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
1.2.5.5.	*Retard*	Continuellement variable entre 0x et 10x le coefficient de temps de la base de temps principale.	Etalonné. Gamme de multiplicateur du temps de retard 0,00 - 9,99. Précision différentielle 0,5 %, typique 0,2 %.
1.2.5.6.	*Instabilité du retard*	1 : 20.000	
1.2.6.	**Deviation X**		
	Déviation X par Y_A ou Y_B	2 mV/div à 5 V/div	Commande continue non-étalonnée 1:2,5 par potentiomètre Y GAIN.
1.2.6.1.	*Erreur de mesure*	± 5 %	
1.2.6.2.	*Bande passante*	0 ... 2 MHz	– 3 dB sur 4 DIV dans le centre horizontal de l'écran.
1.2.6.3.	*Déviation maxi sans distortion*	20 divisions	Jusqu'à 100 kHz
1.2.6.4.	*Déphasage par rapport á l'affichage Y*	3° à 100 kHz	
	Déviation externe X par douille EXT		
1.2.6.5.	*Coefficient de déviation*		
	Ext. Ext. ÷ 10	50 mV/div 500 mV/div	Commande continue non-etalonnée 1:3
1.2.6.6.	*Précision Ext.*	± 3 %	2 % supplémentaire pour Ext.: 10.
1.2.6.7.	*Bande passante*	continu ... 2 MHz 7 Hz ... 2 MHz	par couplage de déclenchement DC par couplage de déclenchement LF ou HF
1.2.6.8.	*Caractéristique d'entrée*	mêmes que pour voies Y	
1.2.6.9.	*Déphasage*	3° à 100 kHz	
1.2.6.10.	*Linéarité*	1,5 %	
1.2.6.11.	*Dérive*	0,2 div/h	

	Désignation	*Spécification*	*Information supplémentaire*
1.2.7.	**Déclenchement de la base de temps principale**		
1.2.7.1.	*Source*	Interne à partir de la voie A Interne à partir de la voie B Composite A et B Interne à partir du secteur Source externe	 Mode vertical alterné uniquement
1.2.7.2.	*Modes*	Automatique	Fonctionnement automatique du générateur de base de temps environ 100 ms après la disparition du signal de déclenchement.
		Balayage simple	La lampe NOT TRIG'D est allumée après remise à zéro et s'éteint en fin de balayage.
1.2.7.3.	*Polarité*	+ ou –	
1.2.7.4.	*Sensibilité*	Internal: 0,5 div. jusqu à 1,5 div à 100 MHz	Sensibilité typique en fonction de la fréquence, voir fig. 1.3.
		external: 50mV jusqu à 150 mV à 100 MHz	Sensibilité typique en fonction de la fréquence, voir fig. 1.4.
		external ÷ 10 : 500 mV jusqu'à 1,5 V à 100 MHz	
1.2.7.5.	*Bande passante du filtre*	DC: 0 - bande totale LF interne: 0 - 30 kHz LF externe: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz AUTO: 20 Hz - bande totale	Réponse uniforme, en interne et en externe –3 dB –3 dB –3 dB, interne et externe
1.2.7.6.	*Gamme de niveau*		
	Déclenchement interne	24 DIV	
	Déclenchement externe	+1,2 V à –1,2 V	
	Externe÷ 10	+ 12 V à – 12 V	
1.2.7.7.	*Caractéristique d'entrée*	1MΩ (± 2%)//≈15pF	
1.2.7.8.	*Instabilité de déclenchement*	$<$0,5 ns	
1.2.8.	**Déclenchement de la base de temps retardée**		
1.2.8.1.	*Source*	Interne à partir de la voie A Interne à partir de la voie B Externe	Les autres caractéristiques à celles mentionnées au paragraphe 1.2.7. DECLENCHEMENT DE LA BASE DE TEMPS PRINCIPALE, à l'exception de Ext.÷ 10 et du déclenchement secteur.
1.2.9.	**Unité d'étalonnage**		
1.2.9.1.	*Tension de sortie*	3 V_{CC}	
1.2.9.2.	*Courant de sortie*	6 mA	
1.2.9.3.	*Erreur limite*	± 1 %	Tension et courant
1.2.9.4.	*Fréquence*	2 kHz ± 2 %	
1.2.9.5.	*Protection*	La sortie est protégée contre des courts-circuits même continus.	

	Désignation	*Spécification*	*Information supplémentaire*
1.2.10.	**Entrées/sorties arrière**		
1.2.10.1.	*Modulation Z*	Couplé en continu Compatible TTL Polarité positive Affichage supprimé Temps de réponse 35 ns Impédance d'entrée 10 kOhm Tension maximale d'entrée 50 V	
1.2.10.2.	*Porte base de temps principale*	0 ... +5 V délivrée pendant le balayage de base de temps principale	En option Impédance de sortie 1 kOhm
1.2.10.3.	*Porte base de temps retardée*	0 ... +5 V délivrée pendant le balayage de base de temps retardée	En option Impédance de sortie 1 KOhm
1.2.11.	**Alimentation**		
1.2.11.1.	*Tensions secteur*	100 ... 127 V (± 10%) alternatif 220 ... 240 V (± 10%) alternatif 250 ... 350 V continu	Protégé automatiquement contre le réglage incorrect du sélecteur secteur
1.2.11.2.	*Fréquence secteur*	46 à 440 Hz	
1.2.11.3.	*Consommation*	50 W	
1.2.11.4.	*Transitoire secteur*		Dans des conditions de transitoire tension et fréquence spécifiée dans MIL-T-28800, l'oscilloscope ne subira aucun dommage.

1.2.12. Conditions ambiantes

Les données relatives aux conditions ambiantes ne sont valables que si l'instrument est contrôlé conformément aux méthodes officielles. Des renseignements sur ces méthodes et sur les critères employés sont fournis sur demande par l'organisation Philips de votre pays ou par le TEST AND MEASURING DEPARTMENT de la N.V. PHILIPS' GLOEILAMPENFABRIEKEN à EINDHOVEN, PAYS-BAS.

1.2.12.1. Tests de température

Conformément à CEI 68 Ab et Bb.
Gamme de référence d'utilisation: +5 °C ... +40 °C
Gamme limite d'utilisation: –15 °C ... +55 °C. Les exceptions aux tolérances sont indiquées par spécification
Conditions de stockage et de transport: – 40°C ... + 70°C. Testé à –55°C ... + 75°C.

1.2.12.2. Altitude

Conformément à CEI 68-2-13, test M.
En fonctionnement: 5000 m
Déviation: 1 °C/300 m pour température maximale
Hors fonctionnement: 17000 m.

1.2.12.3. Chocs

30 g, demi-sinus, durée 11 ms; 2 chocs par axe dans chaque direction, total 12 chocs.

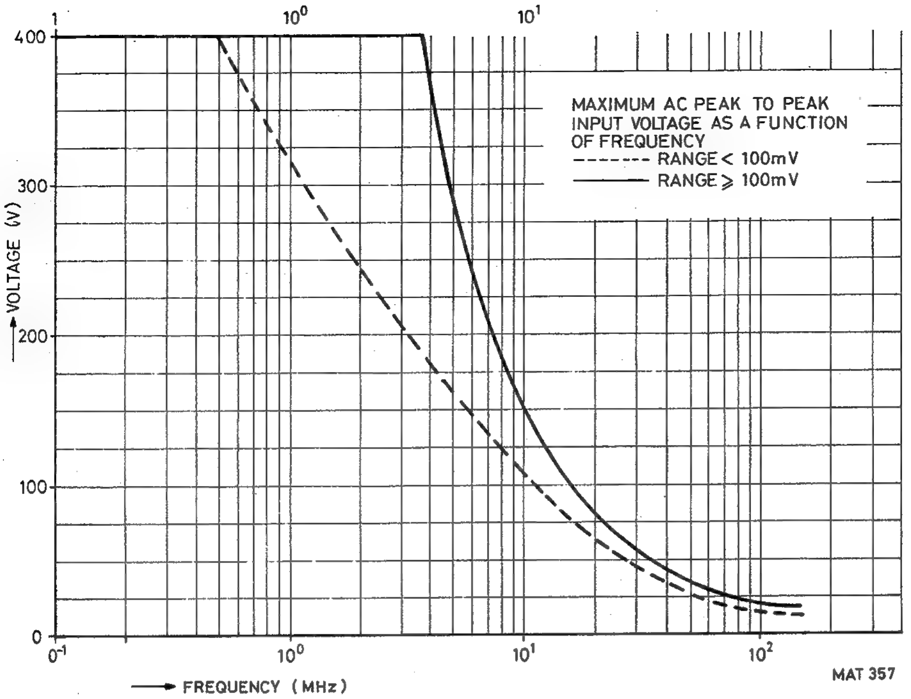


Fig. 1.2. Réduction de la tension d'entrée maximale admise, en fonction de la fréquence

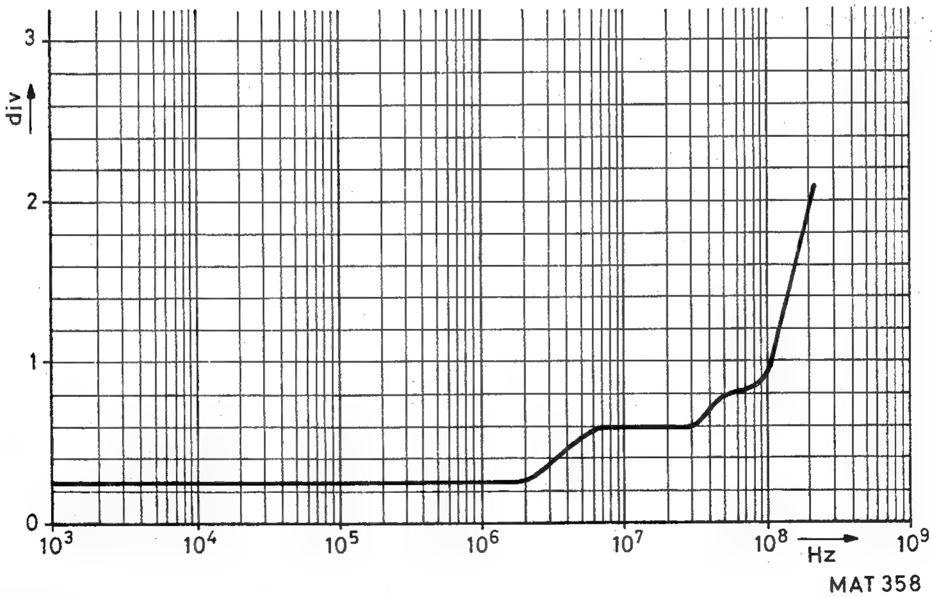


Fig. 1.3. Sensibilités typiques pour déclenchement interne, en fonction de la fréquence

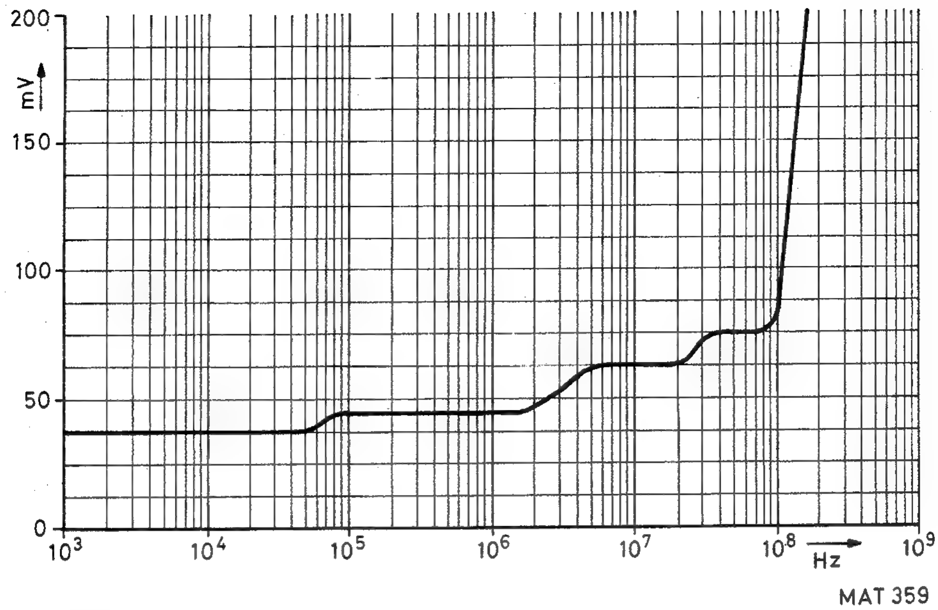


Fig. 1.4. Sensibilités typiques pour déclenchement externe, en fonction de la fréquence

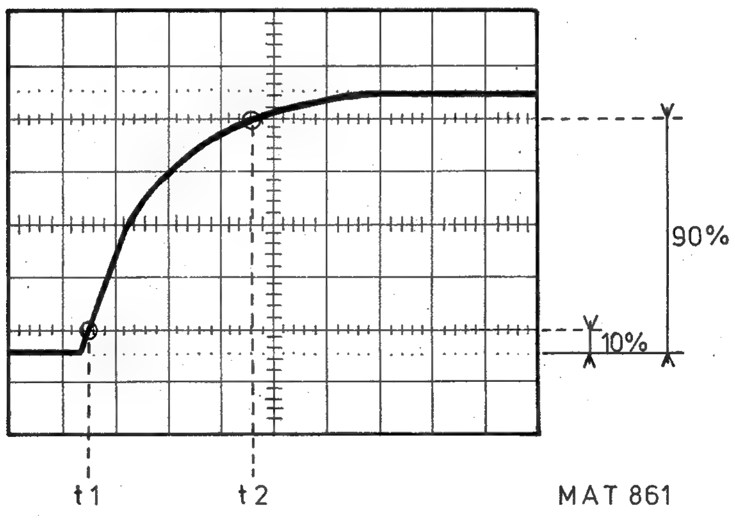


Fig. 1.5. Mesurage du temps de montée $t_R = t_2\ (90\%) - t_1\ (10\%)$

	Désignation	*Spécification*	*Information supplémentaire*

1.2.12.4. *Vibration*

En fonctionnement: 15 min. dans chacune des trois directions.
0,7 mm déplacement crête-à-crête (4g à 55 Hz) à fréquence 10 Hz - 55 Hz - 10 Hz en cycles d'une minute.

1.2.12.5. *Temps de rétablissement*

30 minutes si la température de l'instrument passe de −10 °C à +20 °C sous humidité relative de 60 %.

1.2.12.6. *Blindage magnétique*

Conformément à CEI 351-22.3.1.
Déviation maxi: 1 div.

1.2.12.7. *Interférence électromagnétique*

Conformément à VDE 0871 et 0875, Störgrad K.

1.2.13. Caractéristiques mécaniques

1.2.13.1. *Dimensions*

Longueur	460 mm	Commandes, couvercle et pieds non compris
Largeur	316 mm	
Hauteur	154 mm	

1.2.13.2. *Poids* 10,9 kg

1.3. ACCESSOIRES LIVRES AVEC L'APPAREIL

- Deux sondes passives 10:1
- Filtre de contraste
- Couvercle frontal avec emplacement pour sondes, par example
- Visière pliante PM9366
- Adaptateur BNC banane PM9051
- Adaptateur BNC borne CAL
- Notice d'emploi et d'entretien

1.4. INFORMATIONS CONCERNANT LES SONDES 10:1 LIVRES AVEC L'APPAREIL

La sonde d'attenuation 10x est conçue pour les oscilloscopes PM 3262, PM 3263, PM 3264 et PM 3266.

1.4.1. Caractéristiques techniques

Caractéristique électriques

Atténuation	10x ± 2% (entrée d'oscilloscope 1 MΩ± 1%)
Résitance d'entrée en continu en alternatif	10 MΩ ± 2% (entrée d'oscilloscope 1 MΩ ± 5%) Voir courbe Fig. 1.6.
Capacitance d'entrée en continu et basse fréquence	11pF ± 1pF (entrée d'oscilloscope 1 MΩ ± 5% mis en parallèle par 13pF ± 3pF)
Réactance d'entrée HF	Voir courbe Fig. 1.6.
Largeur de bande	La sonde n'a pas effet sensiblement à largeur de bande d'oscilloscope

Tension maximale d'entrée

500V continu + alternatif (crête), décroissant avec la fréquence. Voir Fig. 1.7.
Entrée d'oscilloscope 1 MΩ et tension appliquée entre pointe de sonde et la partie du corps de sonde mise à la terre. Tension d'essai 1500V continu pendant 1 s à une température entre 15 et 25°C, humidité relative de 80% maximum et au niveau de la mer.

Contrôle du zéro sur boîtier de sonde

Fonction identique à la position 0 du commutateur de couplage d'entrée sur l'oscilloscope

Conditions d'ambiance

La sonde fonctionne conformément aux spécifications dans les conditions suivantes:

Température	–25 à +70°C
Altitude	Jusqu'à 5000 mètres
Autres conditions d'ambiance	Identiques à celles d'application pour l'oscilloscope utilisé avec la sonde

Caractéristiques mécaniques

Dimensions	Corps de sonde 103 mm x 10 m dia (max.) Longueur de câble 1500 ou 2500 mm Boîte de correction 55 x 30 x 15 mm y compris BNC
Masse	125g, y compris les accessoires standard

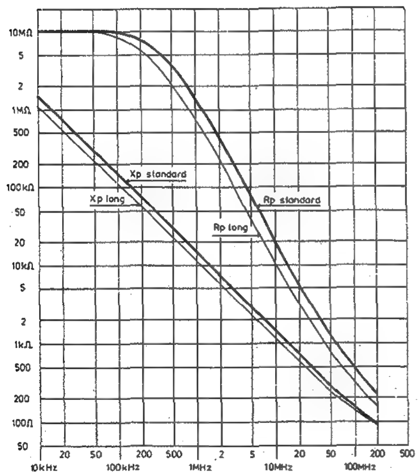


Fig. 1.6. Résistance d'entrée (Rp) et réactance (Xp) par rapport à la fréquence

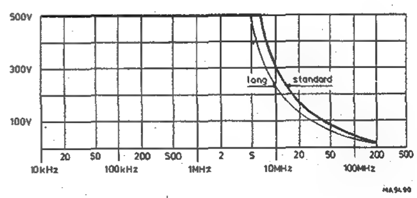


Fig. 1.7. Réglage de tension d'entrée maximale par rapport à la fréquence

1.4.2. Réglages

Adaption de la sonde à l'oscilloscope

La sonde de mesure est réglée et contrôlée par la fabricant. Cependant, pour adapter la sonde à l'oscilloscope, le procédé suivant est requis.
Connecter la pointe de mesure à la prise CAL d'oscilloscope.
Un trimmer (C2) est réglable à travers une ouverture dans la boîte de compensation pour obtenir une réponse rectangulaire optimale. Voir Fig. 1.8b.

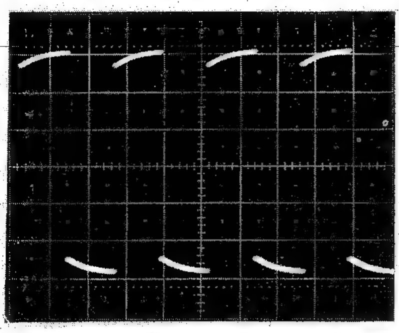


Fig. 1.8a Surcompensation (réglage C2)

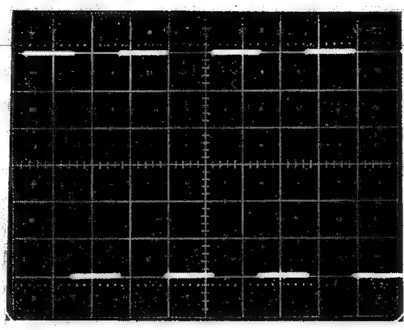


Fig. 1.8b Compensation exacte (réglage C2)

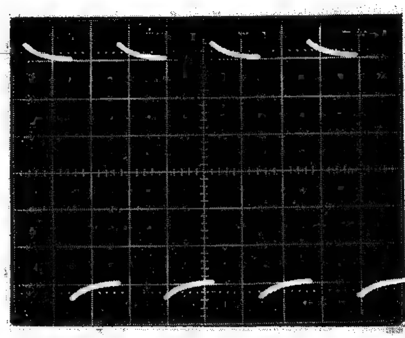


Fig. 1.8c Sous-compensation (réglage C2)

Réglage de la réponse haute fréquence

Le réseau de correction pour réponse haute fréquence est réglé par le fabricant afin d'être adapté à l'entrée d'oscilloscope.
Un rajustage ultérieur ne sera nécessaire que si la sonde doit être appliquée à un oscilloscope de type différent ou après le remplacement d'un composant électrique.
Pour le réglage, procéder comme suit:
Connecter la sonde à un générateur rapide (temps de montée n'excédant pas 1 ns) terminé par son impédance caractéristiques.
Démonter la boîte de compensation. Régler le générateur sur 100 Hz. Ajuster R3 afin d'obtenir l'affichage comme illustré en figure 1.9a.
Il est important que le front d'onde soit aussi escarpé que possible et le sommet aussi plat que possible. Des réglages incorrects de R3 causent des distorsions d'impulsion telles qu'illustrées aux figures 1.9b et 1.9c.

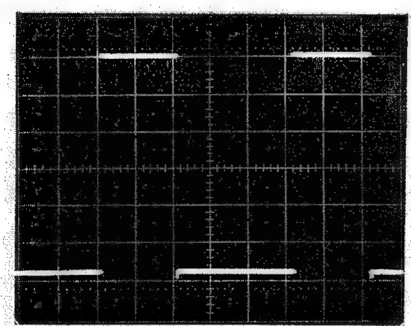


Fig. 1.9a Potentiomètres de pré réglage ajustés correctement

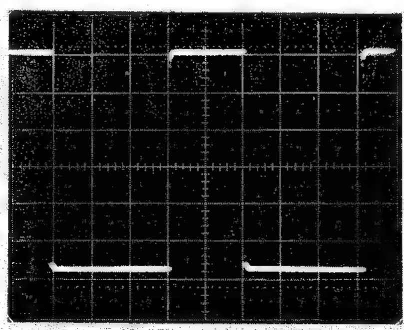


Fig. 1.9b Arrondissement dû au réglage incorrect des potentiomètres

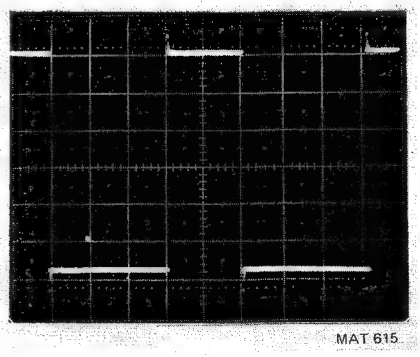


Fig. 1.9c Dépassement dû au réglage incorrect des potentiomètres

Pour la position du potentiomètre R3 dans la boîte de compensation voir fig. 1.12.

1.4.3. Démontage

Démontage de la sonde (voir Fig. 1.10)

La partie avant 11 de la sonde peut être dévissée de la partie arrière 13. Le poste 11 peut dès lors être glissé de 12 et 13.
La combinaison RC 12 est soudée à 13. Pour le remplacement de 12, se référer à la section "Remplacement des composants".

Démontage de la boîte de compensation (Fig. 1.10)

Dévisser le collier strié de la boîte de compensation au câble.
Le boîtier 14 peut être glissé latéralement de la boîte de compensation. Les composants électriques sur le circuit imprimé sont alors accessibles.

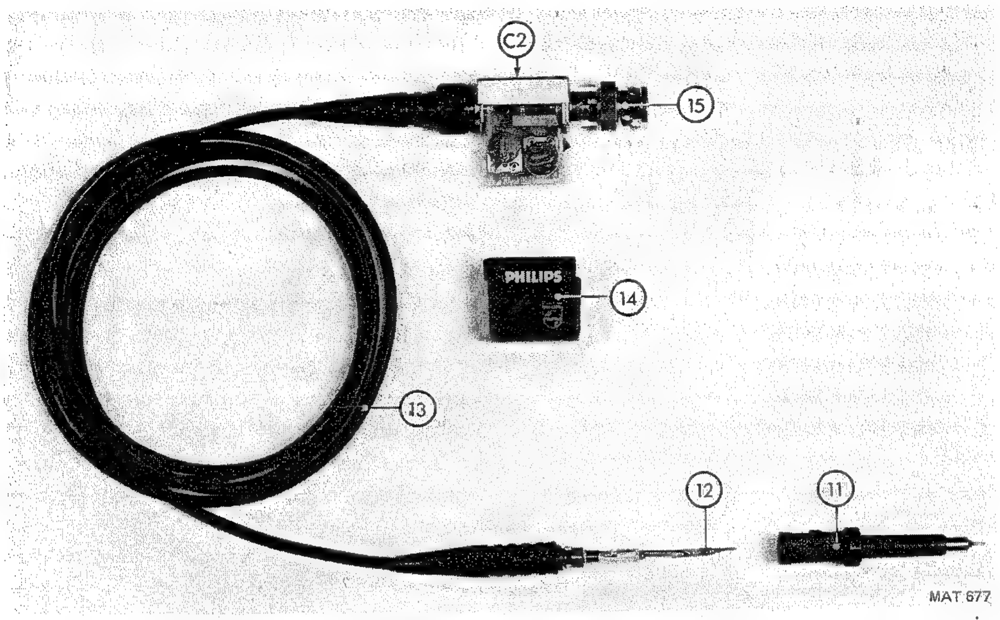


Fig. 1.10 Démontage de la sonde

1.4.4. Remplacement des composants

Assemblage de la sonde

Un nouveau réseau RC est coulissé sur le raccord de câble après quoi le conducteur de câble est soudé au fil de la résistance.
Lorsque la sonde est assemblée, le réseau RC doit se trouver au centre dans la pointe de sonde.

Remplacement du câble

Démonter la boîte de compensation.
Dessouder la connexion entre le conducteur interne et le circuit imprimé. Bien tenir le châssis de la boîte de compensation et desserrer le raccord de câble à l'aide d'une clé hexagonale de 5 mm. Pour l'assemblage, procéder en ordre inverse du démontage.

Remplacement de la pointe de sonde

La pointe endommagé peut être tirée hors de la sonde à l'aide d'un pince. Une nouvelle pointe doit être poussée fermement en place.

1.4.5. Nomenclature des composants

1.4.5.1. Composants mécaniques (Fig. 1.10. et 1.11.)

Les postes 1 à 10 sont des accessoires standard livrés avec la sonde.

Pos.	Numéro de commande	Qté	Description
1	5322 321 20223	1	Câble de terre
2	5322 256 94136	1	Porte-fusible
3	5322 255 44026	5	Bornes à souder pouvant être incorporés dans les circuits comme points de test de routine
4	5322 532 64223	2	Bague rouge
5	5322 532 74224	2	Bague blanche
	5322 532 64225	2	Bague bleue (pas illustrée)
6	5322 268 14017	2	Pointe de sonde
7	5322 462 44319	1	Capuchon isolant couvrant la partie métallique de la sonde pendant les mesures sur des circuits à câblage dense
8	5322 462 44318	2	Capuchon facilitant la mesure sur des circuits intégrés "dual-in-line"
9	5322 264 24018	1	Adaptateur enroulé
10	5322 264 24019	1	Grippe-fil à ressort
11	5322 264 24012	1	Coquille de sonde avec bouton de test zéro
12	5322 216 54152		Réseau RC
13	5322 320 14063		Ensemble de câbles
14	5322 447 64015	1	Capuchon
15	5322 268 44019	1	Connecteur BNC

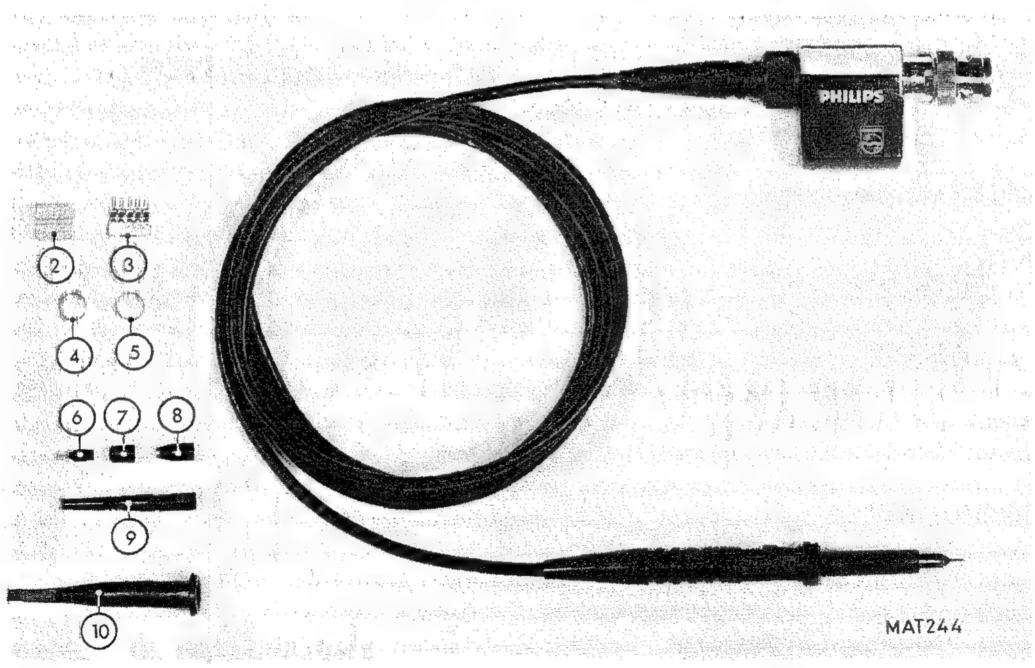


Fig. 1.11. Composants mécaniques de la sonde

1.4.5.2. Composants électriques (voir fig. 1.12.).

Pos.	Numéro de commande	Description
C1	–	Partie du réseau RC (pas fournie séparément).
C2	5322 125 54003	Trimmer 60pF/300Volt.
C3	–	Capacitance 2,7pF.
L1	–	Bobinage
R1	–	Partie du réseau RC (pas fournie séparément).
R2	5322 116 50536	Résistance 464Ω, 1%, MR25.
R3	5322 101 14047	Potentiomètre 470Ω, 20%.
R4	5322 116 50536	Résistance 464Ω, 1%, MR25.
R5	5322 116 54462	Résistance 82,5Ω, 1%, MR25.

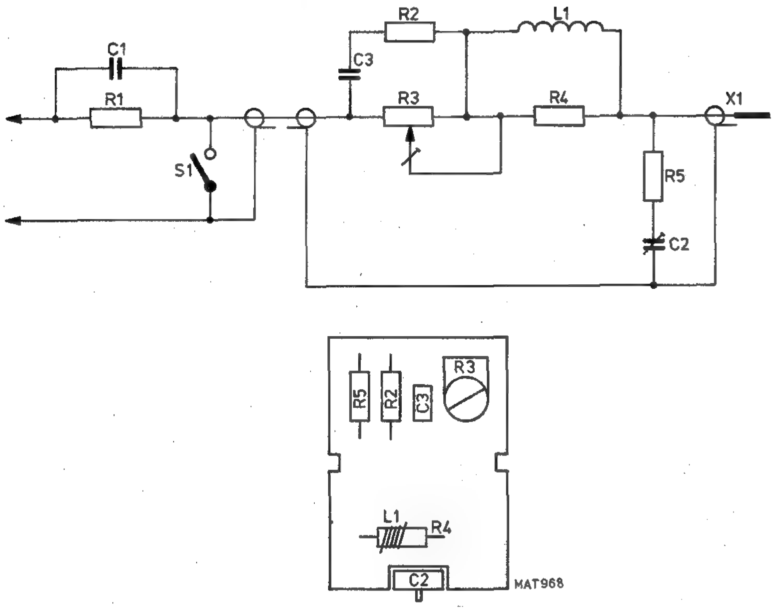


Fig. 1.12. Composants électriques de la sonde et composition de la platine imprimée

1.5. DESCRIPTION DU SCHEMA SYNOPTIQUE DE FONCTIONNEMENT

1.5.1. Déflection verticale

L'appareil présente deux voies identiques A et B, chacune assurant le contrôle et l'amplification des signaux pour respectivement les entrées A et B. A des fins de simplification, on ne décrit que la voie A.

La voie A (CHANNEL A) comprend un commutateur de couplage de signaux AC/O/DC, une commande AMPL/DIV pour régler l'amplification des signaux afin d'obtenir la hauteur désirée de la trace verticale, et une commande de POSITION combinée à une fonction NORMAL/INVERT. Dans les trois positions du commutateur AC/O/DC, le signal d'entrée est appliqué respectivement à l'entrée de l'amplificateur par l'intermédiaire d'un condensateur d'arrêt du courant continu (position AC), le signal d'entrée est interrompu (position O) ou le signal est envoyé directement à l'entrée de l'amplificateur (position DC). Le potentiomètre POSITION assure le contrôle rotatif continu du décalage vertical du signal sur l'écran; l'action de contrôle en push-pull permet d'afficher le signal soit en mode normal soit en mode inversé.

Le déclenchement de la base de temps sur un signal dérivé d'une des voies verticales est possible par l'intermédaire du bloc de commutation de déclenchement composite A/B (A/B COMPOSITE TRIGGER SWITCHING).

Le commutateur VERTICAL CHANNEL SWITCH permet de commuter le signal de sortie de la voie A pour l'envoyer par la ligne de retard (DELAY LINE) et l'amplificateur vertical de sortie (FINAL VERTICAL AMPLIFIER) ou de bloquer ce signal. D'autres sources de signaux pour la ligne de retard (DELAY LINE) et l'amplificateur vertical de sortie (FINAL VERTICAL AMPLIFIER) sont le signal de sortie de la voie B ou le signal TRIGGER VIEW. Ce signal est le signal sur lequel la base de temps principale est déclenchée et il provient de la source de déclenchement de la base principale. Si les voies A et B sont commutées simultanément, les signaux de sortie de ces voies s'ajoutent et la somme est affichée sur l'écran. Le sélecteur de voie verticale (VERTICAL CHANNEL SWITCH) est commandé par la logique de mode d'affichage vertical (VERTICAL DISPLAY MODE LOGIC) qui est commandée par le sélecteur de mode d'affichage vertical A, ALT, TRIG VIEW, CHOP, ADD, B. Si plus d'une voie est affichée l'affichage peut fonctionner en mode découpé (CHOPPED) ou en mode alterné (ALTERNATE). Un signal dérivé de la base de temps principale (MAIN TIME BASE) est utilisé pour la commutation en mode alterné. La ligne de retard (DELAY LINE) assure le retard dessignaux nécessaires pour permettre au flanc montant d'un phénomène rapide d'être affiché sur l'écran.

L'amplificateur vertical de sortie (FINAL VERTICAL AMPLIFIER) commande des plaques de déflexion verticale du tube cathodique. En mode alterné de la base de temps, la commande de séparation de trace (TRACE SEPARATION) permet un décalage de trace vertical réglable entre les signaux des bases de temps principale et retardée pour faciliter la comparaison.

1.5.2. Déflexion horizontale

La source d'entrée pour l'amplificateur horizontal de sortie (FINAL HORIZONTAL AMPLIFIER) peut être soit la base de temps principale (MAIN TIME BASE), soit la base de temps retardée (DELAYED TIME BASE), ou encore l'amplificateur de déflexion horizontale (HORIZONTAL DEFLECTION AMPLIFIER). La source sélectionnée dépend du réglage du commutateur de voie horizontale (HORIZONTAL CHANNEL SWITCH) qui est commandé par la logique de mode d'affichage horizontal (HORIZONTAL DISPLAY MODE LOGIC). Cette logique est commandée par le sélecteur de mode d'affichage horizontal DELD TB, ALT TB, EXT X DEFL, MAIN TB.

La base de temps principale (MAIN TIME BASE) et la base de temps retardée (DELAYED TIME BASE) sont en mesure, toutes les deux, de produire une tension en dents de scie linéaires dans le temps, dont le temps de balayage est réglable à l'aide de la commande TIME/DIV.

SOURCE DE DECLENCHEMENT DE LA BASE DE TEMPS PRINCIPALE/FILTRE/AMPLI DE DECLENCHEMENT (MAIN TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER):
La base de temps principale peut être déclenchée par la voie A ou B, par un signal dérivé de la tension secteur ou par un signal appliqué à l'entrée de déclenchement externe EXT TRIG OR X DEFL. La source de déclen-

chement est sélectionnée à l'aide du sélecteur de la source de déclenchement. Le signal de la source sélectionnée peut être filtré par un filtre basse fréquence, ou un filtre haute fréquence ou peut passer sans être filtré si le bouton DC du commutateur DC/LF/HF est actionné. Le niveau et la pente du signal, auxquels la base de temps est démarrée, peuvent être réglés à l'aide de la commande LEVEL/SLOPE. La source de déclenchement de la base de temps principale sélectionnée peut également servir à la déflexion horizontale par l'intermédiaire de l'amplificateur de déflexion horizontale (HORIZONTAL DEFLECTION AMPLIFIER) et à la voie de déclenchement TRIGGER VIEW par l'intermédiaire du sélecteur de voie verticale (VERTICAL CHANNEL SWITCH)

Source de déclenchement de la base de temps retardée/filtre/amplificateur de déclenchement:

La base de temps retardée peut être déclenchée par la voie A ou B ou par un signal appliqué à l'entrée de déclenchement externe EXT TRIG. Le couplage du signal DC/LF/HF et LEVEL/SLOPE est réglable.

Le bloc portant l'indication COMPARATOR compare le signal en dents de scie de la base de temps principale à une tension DC réglable transmise par le potentiomètre DELAY TIME (temps de retardement). Au moment où la tension en dents de scie correspond au niveau de tension continue ajusté, le COMPARATEUR envoie un signal à la BASE DE TEMPS RETARDEE (DELAYED TIME BASE). Si l'on appuie sur la touche MAIN TB (base de temps principale) du sélecteur de source de déclenchement, la BASE DE TEMPS RETARDEE démarre alors immédiatement. Si l'on appuie sur la source A, B ou EXT du sélecteur de source de déclenchement, la BASE DE TEMPS RETARDEE démarre après le signal du COMPARATEUR, après réception d'une impulsion de déclenchement émise par la source de déclenchement sélectionée.

1.5.3. Section Z et section focalisation

L'amplificateur Z reçoit un signal d'entrée qui détermine l'intensité du spot sur l'ecran, par l'intermédiaire du Cylindre de Wehnelt (G1) du tube cathodique. La focalisation du spot est par ailleurs influencée. Le tube cathodique possède des électrodes séparées pour la concentration dans le sens vertical (G5) et dans le sens horizontal (G3). Ces électrodes sont contrôlées respectivement par l'AMPLIFICATEUR DE FOCALISATION VERTICALE (VERTICAL FOCUS AMPLIFIER) et l'AMPLIFICATEUR DE FOCALISATION HORIZONTALE (HORIZONTAL FOCUS AMPLIFIER).
Les deux amplificateurs reçoivent leur signal d'entrée de l'AMPLIFICATEUR Z (Z AMPLIFIER).
L'amplificateur de focalisation horizontale est contrôlé par la commande du panneau avant marqué FOCUS.
Les signaux qui contrôlent l'intensité et la concentration du spot sont les suivants:

- Le réglage de la commande du panneau avant INTENS.
- Un signal du suppression pour le mode d'affichage à découpage, provenant de la logique du mode d'affichage vertical.
- Un signal de suppression de l'affichage pendant la période de blocage de la base de temps principale, est émis par cette dernière.
- Un signal émis par l'INTERRUPTEUR DE VOIE HORIZONTALE (HORIZONTAL CHANNEL SWITCH) pour la partie intensifiée du signal de base de temps retardée sur le signal de base de temps principale.
- Un signal qui peut être appliqué à l'entrée de modulation Z externe, marquée Z-MOD.
- Un signal provenant du SYSTEME DE MEMOIRE (MEMORY SYSTEM) pour la suppression de l'affichage, si aucun signal n'est en cours de stockage.

1.5.4. Système de mémoire et principe de stockage.

Cet appareil est équipé d'un tube à mémoire spécial. Le système de mémoire se compose d'une GRILLE DE MEMOIRE FRONTALE,(FRONT MEMORY MESH), d'une GRILLE DE MEMOIRE RAPIDE (FAST MEMORY MESH) et de CANONS AUXILLIAIRES (FLOOD GUNS).
Chaque grille de mémoire est une grille métallique placée derrière l'écran et à quelques millimètres de celui-ci. Le côté de la grille qui fait face au système d'enregistrement (cathode G1, G2 et G5) est revêtu d'une couche diélectrique. Le principe de stockage repose sur l'émission secondaire dans la couche de diélectrique. Aux endroits où des électrons à haute énergie, provenant du système d'enregistrement, frappent la grille de mémoire, le nombre des électrons qui en partent est supérieur à celui des électrons qui la frappent. Ces emplacements portent une charge positive. Les canons auxilliaires produisent alors une nuage d'électrons à basse énergie, qui couvrent toute la surface de la grille de mémoire. Ces électrons peuvent traverser la grille de mémoire aux endroits où elle a reçu une charge positive. Après avoir traversé la grille, ils sont attirés par la très haute tension positive de l'accélerateur final. Une réplique du schéma de répartition des charges présente dans la grille de mémoire est par conséquence affichée sur l'écran.

En mode d'ECRITURE (MAX) WRITE seule la grille de mémoire frontale est écrite. La vitesse d'écriture de d'écriture de cette grille est suffisante pour les signaux rapides. Toutefois, la charge positive qui est écrite peut persister pendant une période prolongée.

En mode RAPIDE, la grille de mémoire rapide et la grille de mémoire frontale sont toutes deux employées. Cette dernière grille est composée de manière à permettre l'écriture des signaux très rapides. Toutefois, la charge positive qui est écrite ne persiste que pendant un court instant. C'est pourquoi, dès que la grille de mémoire rapide à été écrite (à la fin du balayage de la base de temps) le schéma de charge est transféré à la grille de mémoire frontale: c'est que l'on appelle le transfert d'image. Le transfer est effectué grâce aux électrons provenant des canons auxiliaires. Après le transfert, la réplique du schéma de charge présente dans la grille de mémoire frontale est affichée sur l'écran.

Le transfert d'image est effectué grâcé à un certain nombre d'impulsions appliquées à la grille frontale, à la grille rapide et aux canons auxilliaires. Par ailleurs, pour l'effacement du schéma de charge dans les grilles de mémoire, certaines impulsions doivent être appliquées aux électrodes du système de mémoire. Toutes les impulsions requises pour un bon fonctionnement du système dans les divers modes sont générées par la logique de STOCKAGE (STORAGE LOGIC) pour être ensuite amplifiées jusqu'au potentiel requis par les AMPLIFICATEURS DE STOCKAGE (STORAGE AMPLIFIERS). La logique de stockage est controlée par le sélecteur de mode STORE (mémoire), MEMORY OFF (arrêt mémoire), WRITE (écriture), FAST (rapide), ERASE (effacement) et par les commandes PERSISTENCE/VIEW TIME (temps de visualisation) et INTENS.

1.5.5. Alimentation

L'alimentation secteur est stabilisée et fournit les tensions continues d'alimentation des circuits électronique de l'appareil, la haute tension positive du premier accélerateur du tube cathodique, la haute tension négative de la cathode du tube cathodique. En outre, l'alimentation fournit un signal lié à la tension secteur à des fins de déclenchement de la base de temps principale.

2. INSTALLATION

2.1. REGLEMENTS DE SECURITE (CONFORMES A LA CEI 348)

Avant de brancher l'instrument sur le secteur, examiner le boîtier, les commandes, les connecteurs, etc. afin de s'assurer qu'il n'y a pas eu de dommages en cours de transport. En cas de défauts, ne pas brancher l'instrument.

RECLAMATIONS: En cas de dommages ou d'insuffisances, ou si la sécurité de l'appareil est mise en doute, une réclamation doit être adressée directement au transporteur. De plus, il faudra également avertir une organisation de vente ou de service Philips afin de faciliter le procédé de réparation.

Avant de procéder à toute autre connection, la borne de terre de l'instrument doit être reliée à la ligne de terre du réseau (voir 2.4 mise à la terre).

REMARQUE:	L'ouverture des capots ou l'enlèvement d'organes à l'exception de ceux directement accessibles à la main, sont susceptibles de découvrir des composants et des connecteurs sous tension.

L'instrument doit être débranché de toute source de tension avant de procéder à un réglage, un remplacement, une opération d'entretien ou une réparation nécessitant l'ouverture de l'instrument.
Si le réglage, l'entretien ou la réparation de l'instrument ouvert sous tension sont inévitables, seule une personne qualifiée peut se charger de cette tâche.
Ne pas oublier que les condensateurs à l'intérieur de l'instrument peuvent être chargés, même si l'instrument est déconnecté de toute source de tension.

2.2. DEMONTAGE ET MONTAGE DU COUVERCLE AVANT (voir Fig. 2.1.)

Démontage:

– Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche (position UNLOCKED).
– Enlever le couvercle.

Montage:

– Tourner le bouton de verrouillage vers position UNLOCKED.
– Fixer le couvercle sur la partie avant de l'oscilloscope.
– Enfoncer le bouton et le tourner d'un quart de tour vers la droite (position LOCKED).

2.3. POSITION DE L'APPAREIL

L'instrument peut être utilisé en toute position. A poignée rabattue, l'instrument peut être utilisé en position inclinée. Les spécifications conformément aux paragraphe 1.2. ne sont garanties qu'en position normale ou avec poignée rabattue (s'assurer que la grille de ventilation au-dessus et en-dessous du boîtier n'est pas obturée).
Il n'est pas recommandé de placer l'instrument en plein soleil ou sur une surface produisant de la chaleur.
La poignée peut être tournée en appuyant sur les boutons-poussoirs aux étriers.

Fig. 2.1. Dépose du couvercle frontal

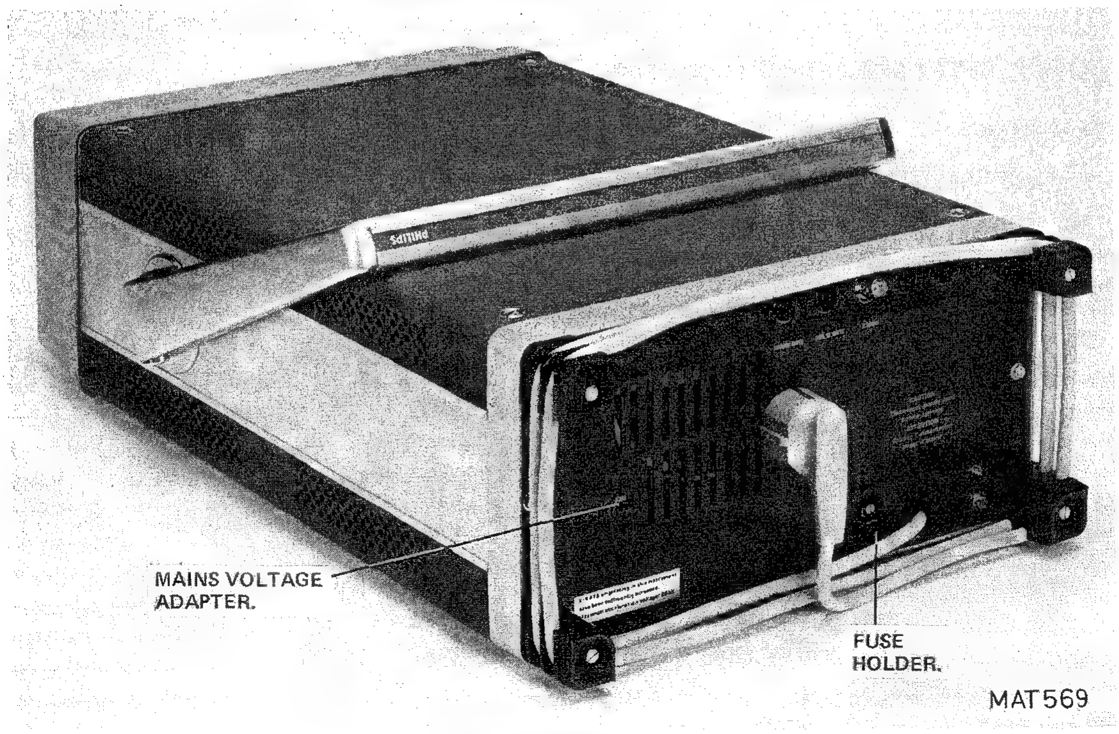


Fig. 2.2. Vue arrière de l'appareil, réglage secteur et fusible

2.4. MISE A LA TERRE

Avant toute mise sous tension, l'instrument doit être connecté à la terre.
- Par la borne de terre de l'appareil.
- Par le cordon secteur à trois conducteurs. La fiche secteur ne sera introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'un câble prolongateur sans conducteur de terre.

ATTENTION:	Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'instrument, tout débranchement de la borne de terre peut rendre l'instrument dangereux. L'interruption intentionnelle de la ligne de terre est formellement interdite.

Lorsqu'un instrument passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

2.5. ADAPTATION A LA TENSION SECTEUR ET FUSIBLE

Avant de raccorder le secteur, s'assurer que l'instrument est réglé sur la tension secteur locale.
L'appareil peut fonctionner sur deux gammes de tension secteur 100 ... 127 V en alternatif (± 10 %) et 220 ... 240 V en alternatif (± 10 %). Cette dernière gamme est également sélectionnée pour le fonctionnement en continu entre 250 et 350 V. La sélection de gamme se fait à l'aide du commutateur coulissant situé derrière la fenêtre à l'arrière de l'appareil. La gamme sélectionnée est visible par cette fenêtre, voir fig. 2.2.
Toujours déconnecter l'appareil de toute source de tension avant d'accéder au sélecteur de gamme.
Le sélecteur est accessible après dépose du panneau arrière (fixé par 2 vis).
L'appareil est protégé contre le réglage incorrect du sélecteur de gamme secteur.
Le porte-fusible monté sur le panneau-arrière porte un fusible lent de 2A.

En cas de remplacement, les fusibles de rechange seront correctement calibrés et d'un modèle adéquat.
Il faut éviter d'utiliser des fusibles réparés ou de court-circuiter des porte-fusibles. En cas de remplacement d'un fusible ou d'adaptation à une autre tension secteur, l'instrument sera débranché de toute source de tension.

3. INSTRUCTIONS D'UTILISATION

3.1. GENERALITES

La présente section décrit les travaux et précautions requises à l'utilisation. En outre, elle décrit sommairement les fonctions des commandes et des indicateurs et met en évidence les aspects pratiques du fonctionnement. De la sorte, un opérateur peut rapidement se familiariser avec les fonctions principales de l'instrument.

3.2. ENCLENCHEMENT

Lorsque l'instrument est branché au secteur comme indiqué aux paragraphes 2.4 et 2.5, il peut être enclenché à l'aide du bouton poussoir POWER. Le commutateur POWER est incorporé dans la commande d'illumination de graticule ILLUM (panneau avant), immédiatement sous le bord de l'écran. Le témoin POWER ON/OFF est proche de la commande ILLUM.
L'instrument est immédiatement en état de fonctionner, après enclenchement. Les caractéristiques techniques selon le paragraphe 1.2 ne sont valables que dans une situation normale — conforme à la section 2 — et après un temps d'échauffement de 30 min.

ATTENTION:	L'instrument ne doit jamais être enclenché lorsqu'une platine ou un bloc a été enlevé. Ne déposer de platine ou de bloc qu'une minute au moins après la mise hors service de l'instrument.

3.3. EXPLANATION DES COMMANDES ET PRISES (voir fig. 3.1.)

3.3.1. Voies verticales

A, ALT, TRIG VIEW, CHOP, ADD, B (S1)	Commandes du mode d'affichage vertical; sélecteur à 6 boutons-poussoirs.
Poussoir A enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie A.
Poussoir ALT enfoncé	L'affichage est permuté d'une voie verticale à l'autre, et ce à la fin de chaque cycle du signal de base de temps; par ex. les voies A et B sont représentées sur les balayages ALT.
Poussoir TRIG VIEW enfoncé	L'affichage est commuté pour visualiser le signal de déclenchement sélectionné. Il peut être interne par les voies A ou B (A ou B de S22 enfoncé) ou externe par la douille d'entrée externe X7 (EXT ou EXT ÷ 10 de S22 enfoncé).
Poussoir CHOP enfoncé	L'affichage est permuté d'une voie verticale à l'autre à une fréquence fixe, les deux voies étant affichées sur le même balayage.
Poussoir ADD enfoncé	La déviation verticale est obtenue par la somme des signaux A et B.
Poussoir B enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie B.
Toutes les poussoirs relâchés	Si aucun bouton-poussoir n'est enfoncé, l'appareil fonctionne en mode ALT.
Poussoirs ALT et TRIG VIEW enfoncés simultanément	Les signaux sur voies A, B et TRIG VIEW sont affichés pendant les balayages alternés; normalement appropriés pour des signaux haute fréquence. (Voir aussi explication bouton-poussoir TRIG VIEW)

Poussoirs CHOP et TRIG VIEW enfoncés simultanément	Les signaux sur voies A, B et TRIG VIEW sont affichés successivement à la fréquence CHOP pendant le même balayage, normalement appropriés pour des signaux basse fréquence. (Voir aussi explication bouton-poussoir TRIG VIEW).
POSITION (R3, R4)	Commande continûment variable pour décadrage vertical de l'affichage.
PULL TO INVERT (S4, S5)	Commutateur tirette intégré à la commande POSITION, pour inversion de la polarité du signal. La polarité est inversée en position tirée.
AMPL/DIV (S9, S11)	Commande échelonnée à 11 positions des coefficients de déviation verticale.
CAL AMPL/DIV (R8/S10, R9/S12)	Commande continuellement veriable des coefficients de déviation verticale. En position CAL. le coefficient de déviation est étalonné.
UNCAL (V4, V5)	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.
GAIN (R12, R13) (accessible par tournevis)	Commande continuellement variable du gain des voies verticales.
AC, 0, DC (S17, S18)	Mode de couplage du signal d'entrée; commutateur à trois positions.
AC enfoncé	Couplage par l'intermédiaire d'un condensateur de liasion.
0 enfoncé	La connexion entre l'entrée de l'amplificateur et la prise d'entrée est interrompue et l'entrée de l'amplificateur est mise à la terre.
DC enfoncé	Couplage direct. Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton AC est enfoncé. Pour visualiser des impulsions de longue durée ou des niveaux continus, il faut sélectionner DC. Pour des ondes alternatives avec importants niveaux continus, il faut sélectionner AC.
A 1MΩ - 15 pF (X3)	Prise d'entrée BNC pour voie A.
B 1MΩ - 15 pF (X4)	Prise d'entrée BNC pour voie B.

3.3.2. Voie horizontale

DEL'D TB, ALT TB, EXT. X DEFL, MAIN TB (S2)	Commandes du mode d'affichage horizontal; par commutateur à boutons-poussoirs.
Poussoir DEL'D TB enfoncé	La déviation horizontale est fournie par le générateur de base de temps retardée.
Poussoir ALT TB enfoncé	L'affichage horizontal est permuté de base de temps principale en base de temps retardée à la fin de chaque cycle du générateur de base de temps principale.
Poussoir EXT. X DEFL enfoncé	La déviation horizontale peut être obtenue par un signal d'origine extérieure appliqué à la prise d'entrée (X7) de l'amplificateur horizontal, par le signal de voie A, par le signal de voie B, par le signal composite, ou par un signal à la fréquence du secteur en fonction de la sélection TRIG ou X DEFL (S22).
Poussoir MAIN TB enfoncé	La tension de déviation horizontale est fournie par le générateur de base de temps principale. Une partie de la trace est intensifiée (sauf en position OFF du commutateur TIME/DIV du générateur de base de temps retardée) **Si aucun bouton n'est enfoncé,** on obtient le même effet que lorsque le bouton MAIN TB est enfoncé.

POSITION TB MAGN (R2, S3)	Commande continuellement variable pour le positionnement horizontal des traces; cette commande comprend un commutateur push-pull qui augmente le coefficient de déviation horizontale d'un facteur 10.
MAGN (V3)	Une lampe témoin indiquée X10 s'allume lorsque cette loupe est utilisée.
X AMPL, HOLD -OFF (R18)	Commande continuellement variable des coefficients de déviation horizontale dans le cas de déviation par un signal extérieur. Dans le case de déviation X par la base de temps principale, cette commande peut être utilisée pour augmenter le temps de blocage du balayage.
TRACE SEP. (R6);	Commande de pré -réglage continûment variable de l'espace vertical entre les deux affichages de base de temps en mode ALT TB.

3.3.3. Générateur de base de temps principale

LEVEL SLOPE (R7, S7)	Commande continuellement variable pour sélectionner le niveau du signal de déclenchement, auquel le générateur de base de temps principale démarre. Cette commande comprend un commutateur push-pull, qui permet de déclencher sur le front positif ou négatif du signal de déclenchement (enfoncé +, tiré –).
NOT TRIG'D (V2)	Lampe témoin qui s'allume lorsque le générateur de base de temps principale est en position d'attente.
AUTO, TRIG, SINGLE	Commande de mode de déclenchement; commutateur à trois boutons-poussoirs.
Poussoir AUTO enfoncé	Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.
Poussoir TRIG enfoncé	Le générateur de base de temps est déclenché normalement.
Poussoir SINGLE enfoncé	Le générateur de base de temps ne démarre qu'une seule fois à la réception d'une impulse de déclenchement. Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE.
TIME/DIV or DELAY TIME (S15)	Commande de la vitesse de balayage de la base de temps principale; commutateur rotatif à 23 positions.
CAL (bleu) - TIME/DIV (R11, S16)	Commande continuellement variable de la vitesse de balayage de la base de temps principale. (En position CAL, la vitesse de balayage est étalonnée).
UNCAL (V6)	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.
DC, LF, HF (S20)	Choix du couplage de déclenchement: commutateur à 3 positions.
DC	Les signaux de déclenchement sont couplés directement.
LF	Couplage par le filtre passe-bas pour des fréquences allant jusqu'à 30 kHz (de 7 Hz à 30 kHz pour déclenchement externe, par filtre passe-bande).
HF	Couplage par un filtre passe-haut pour des fréquences supérieures à 30 kHz. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la touche DC était enfoncée.
TRIG or X DEFL	Commutateur à 4 boutons-poussoirs qui permet de sélectionner ou la source de déclenchement ou la déviation X par une source extérieure. Déviation X seulement si le bouton-poussoir EXT X DEFL de S2 (commandes de mode d'affichage horizontal)

Poussoir A enfoncé	Signal de déclenchement interne ou de déviation X provenant de la voie A.
Poussoir B enfoncé	Signal de déclenchement interne ou signal de déviation X provenant de la voie B.
COMP (A et B enfoncés simultanément)	Signal de déclenchement interne ou signal de déviation X provenant des voies A et B.
EXT	Déclenchement par un signal externe appliqué à la prise adjacente 1 MOhm - 15 pF (X7). Lorsque le bouton EXT X DEFL des commandes de déviation horizontale est enfoncé, cette prise est connectée à l'entrée de l'amplificateur horizontal.
EXT ÷ 10	Déclenchement externe ou déviation X comme pour EXT mais atténué du facteur 10.
LINE (EXT et EXT ÷ 10 enfoncé simultanément)	Signal de déclenchement ou de déviation X provenant d'une tension interne à la fréquence du secteur. Si aucun bouton n'est enfoncé, aucun mode n'est sélectionné.
1 MOhm - 15 pF (X7)	Prise BNC pour déclenchement externe ou déviation horizontale.

3.3.4. Générateur de base de temps retardée

DELAY TIME MULTIPLIER (R1)	Commande continuellement variable du temps de retard, utilisée en association avec les commandes TIME/DIV du générateur de base de temps principale.
LEVEL-SLOPE (R5, S6)	Commande continuellement variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement (enfoncé +, tiré –).
TIME/DIV (S13)	Commande du coefficient de temps pour base de temps retardée; commutateur rotatif à 23 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclencé.
CAL (bleu) TIME/DIV (R10, S14)	Commande continuellement variable du coefficient de temps de la base de temps retardée, En position CAL, le coefficient de temps du commutateur est étalonné.
UNCAL (V6)	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.
DC, LF, HF (S19)	Couplage de déclenchement; commutateur à 3 boutons-poussoirs.
DC	Les signaux de déclenchement sont couplés directement.
LF	Couplage par un filtre passe-bas pour les fréquences jusqu'à 30 kHz (pour le déclenchement par un signal exterieur, le filtre passe-bas agit de 7 Hz à 30 kHz).
HF	Couplage par un filtre passe-haut pour fréquences supérieure à 30 kHz. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton DC était enfoncé.
A, B, EXT, MAIN TB (S21)	Commande de la source de déclenchement; commutateur à 4 boutons-poussoirs.
A	Signal de déclenchement interne prélevé de la voie A.
B	Signal de déclenchement interne prélevé de la voie B
EXT	Déclenchement par application d'un signal externe à la douille adjacente 1 MOhm - 15 pF.

MAIN TB	La base de temps retardée démarre immédiatement après le temps de retard. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton A était enfoncé.
1 MOhm - 15 pF (X6)	Prise d'entrée BNC pour le signal de déclenchement externe.

3.3.5. Tube à rayons cathodiques

INTENS/POWER ON	Commutateur secteur ON/OFF: en circuit, la diode LED est allumée. En mode (MAX) WRITE, FAST ou MEMORY OFF: la position du bouton détermine l'intensité de l'onde écrite sur la couche mémoire du TRC. En mode STORE: la position du bouton détermine la luminosité de l'onde reproduite sur l'écran TRC. Le temps de mémoire diminue en fonction de la luminosité croissante.
STORE/WRITE/FAST/ERASE/ MEMORY OFF	Bouton-poussoir pour commande du système de mémoire.
STORE	Permet de mémoriser une onde pour visualisation prolongée. La commande INTENS est fonctionnelle.
WRITE	Permet d'enregistrer une onde à vitesse d'écriture normale. Les commandes PERSISTENCE et INTENS sont fonctionnelles.
FAST	Permet d'enregistrer une onde à grande vitesse d'écriture. Les commandes VIEW TIME et INTENS sont fonctionnelles.
ERASE	Permet d'effacer l'onde écrite sur la couche mémoire du TRC. Cette commande n'est pas fonctionnelle en mode STORE.
MEMORY OFF	Lorsque les boutons STORE et WRITE sont enfoncés simultanément la fonction mémoire du TRC est mise hors service.

Si une combinaison erronée de boutons est utilisée, l'appareil fonctionne en mode STORE.

PERSISTENCE/VIEW TIME	Cette commande permet, en mode WRITE, de retenir de façon variable l'onde enregistrée (persistance variable). La position MAX résulte en une vitesse d'écriture croissante (environ 10 fois supérieure). Le TRC présente une certaine illumination de fond. En mode FAST, l'effacement automatique et l'enregistrement d'une nouvelle image a lieu après un certain temps. Ce temps est déterminé par la position du bouton VIEW TIME. En position MAX de ce bouton, l'enregistrement d'une nouvelle image n'a lieu qu'après avoir enfoncé le bouton ERASE. Le TRC présente une certaine illumination de fond.
VAR/MAX WRITING SPEED (S27, R20 panneau arrière)	Commutateur S27 permet selection entre vitesse d'écriture maximale avec une certaine illumination de fond et vitesse d'écriture plus basse sans illumination de fond (ajustable avec potentiomètre R20, par tournevis).

FOCUS

Commande continûement variable de focalisation du faisceau électronique TRC dans le sens horizontal.
La focalisation verticale dépend de la commande INTENS. Elle est exacte pour pratiquement toute la gamme. Pour les positions extrêmes de INTENS, la focalisation verticale est réglable à l'aide d'un potentiomètre accessible par un trou de ventilation côte gauche de l'appareil. La plus grande vitesse d'écriture (mode FAST) n'est possible que si la focalisation du faisceau est optimale.

TRACE ROT (R15)

Commande de pré-réglage pour aligner la trace avec les lignes de graticule.
Par tournevis, accessible par un trou de ventilation côte gauche de l'appareil.

3.3.6. Divers

CAL (X1, X2)

Prise de sortie sur laquelle une tension rectangulaire de 3 Vcc et un courant de 6 mA sont disponibles à une fréquence de 2 kHz à des fins d'étalonnage.

⏚ (X5)

Douille de terre de mesure.

Z-MOD (X8) à l'arrière

Douille d'entrée pour modulation Z externe.

3.4. REGLAGES PRELIMINAIRES

Etant donné que les réglages suivants sont identiques pour les deux voies verticales, seul le processus pour la voie A est décrit.
Sauf indications contraires, les commandes occupent la même position que pour le processus de réglage précédent.

3.4.1. Réglage du gain

- Actionner le bouton-poussoir A du sélecteur de mode de déclenchement (S22).
- Actionner le bouton-poussoir A des commandes de mode d'affichage (S1).
- Actionner le bouton-poussoir MAIN TB des commandes de déviation horizontale (S2).
- Centrer la trace avec la commande POSITION appropriée.
- Régler les commandes INTENS et FOCUS afin d'obtenir une trace nette et fine.
  Les commandes non-mentionnées peuvent occuper n'importe quelle position.
- Régler le commutateur AC-0-DC sur DC.
- Régler le commutateur AMPL sur .5 V et la commande continue sur CAL (étalonnée).
- Connecter la prise d'étalonnage CAL à la prise d'entrée A.
- Vérifier si la hauteur de trace est exactement de 6 divisions.
  Au besoin, rajuster la commande GAIN sur le panneau avant, juste sous le commutateur AMPL.

3.5. ENTREES A ET B ET LEURS POSSIBILITES

L'oscilloscope est pourvu de deux voies identiques, toutes deux pouvant être utilisées soit pour des mesures YT avec un ou deux générateurs de base de temps, soit pour des mesures XY avec la voie horizontale externe.

3.5.1. Mesures YT

Pour afficher un signal d'une des voies verticales, il suffit d'actionner le bouton-poussoir A ou B des commandes de mode d'affichage vertical.
Lorsque le bouton-poussoir ALT ou CHOP est enfoncé, deux signaux différents peuvent être affichés simultanément. Le coefficient de déviation Y et la polarité peuvent être sélectionnés pour chaque voie séparément. Lorsque le bouton ALT est actionné, l'affichage est commuté d'une voie à l'autre au retour du signal de base de temps.
Quoique le mode ALTERNATE puisse être utilisé à toutes les vitesses de balayage du générateur de base de temps, le mode CHOPPED donne une meilleure qualité d'affichage pour longs temps de balayage. En effet, pendant les temps de balayage longs, l'affichage alterné des deux signaux d'entrée est visible.

En mode CHOPPED, l'affichage est permuté d'une voie à l'autre à une fréquence fixe.
Si le bouton-poussoir ADDED du commutateur de mode d'affichage est actionné, les signaux des deux voies verticales sont additionnés. En fonction des positions des commutateurs de polarité, la somme ou la différence des signaux d'entrée est affichée. Le mode ADDED permet également des mesures différentielles.
Lorsque les commutateurs de polarité des deux voies sont mis en positions opposées, les parties mode commun des signaux aux prises A et B subissent une très légère amplification par rapport aux parties de mode différentiel.

3.5.2. Mesures XY

Si les bouton-poussoirs EXT X DEFL S2 des commandes de déviation horizontale et une des commandes TRIG OR X DEFL sont actionnés, les générateurs de base de temps sont déconnectés. Si par exemple le bouton-poussoir A de S22 est enfoncé, un signal appliqué à la voie verticale A est alors utilisé pour la déviation horizontale. Le commutateur AC/0/DC et l'atténuateur par échelons de la voie A restent en service. Le décadrage horizontal est possible à l'aide de la commande X POSITION et la commande continue des coefficients de deflection avec A AMPL/DIV.

La voie verticale B peut également être utilisée pour la déviation X. Pour ce faire, le bouton B des commandes TRIG OR X DEFL doit être enfoncé.
Pour la déviation X, il est également possible d'utiliser une tension interne à la fréquence secteur ou un signal extérieur appliqué à la douille EXT située sur la partie inférieure droite du panneau, après avoir enfoncé le bouton-poussoir correspondant des commandes TRIG OR X DEFL. Dans ces modes, la largeur de trace peut être commandée avec le potentiomètre X DEFL/HOLD OFF.
Lorsque ce potentiomètre est en position CAL, le coefficient de déviation pour un signal extérieur est de 50 mV/DIV.
Le signal externe peut être couplé en continu ou en alternatif (fréquence inférieure 7 Hz) en enfonçant le bouton DC ou LF des commandes de déclenchement de la base de temps.

3.5.3. Commutateur AC/0/DC

Les signaux observés sont appliqués aux prises d'entrées A et/ou B et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur vertical est couplé directement, tout la bande passante de l'appareil est disponible et les composantes continues sont affichées comme des décalages de trace en position DC du commutateur AC/0/DC. Ceci peut ne pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.
Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus et basse fréquence. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

3.6. DECLENCHEMENT

Lorsqu'un signal doit être représenté, la déviation horizontale doit toujours être démarrée à un point fixe du signal, et ce afin d'obtenir une trace stationnaire. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans l'unité de déclenchement et commandé par un signal qui peut provenir: d'un des signaux appliqués aux entrées verticales, d'une tension interne à la fréquence du secteur, ou d'une source extérieur.

3.6.1. Couplage de déclenchement

Trois méthodes de couplage de déclenchement sont possibles avec le commutateur DC/LF/HF. En positions HF et LF, la caractéristique de transfert est limitée.
En position DC, le signal de déclenchement reste inchangé.
En position LF, un filtre passe-bande de 0 Hz (7 Hz pour déclenchement externe) à 30 kHz est incorporè
Cette position peut être utilisée pour réduire l'interférence du bruit.
En position HF, un filtre passe-haut de 30 kHz est incorporé.
Cette position peut être utilisée pour réduire l'interférence du ronflement par exemple.

3.6.2. Sélection de la source de déclenchement et réglage du niveau de déclenchement

Le signal de déclenchement est obtenu à partir de la voie A (bouton A enfoncé), de la voie B (bouton B enfoncé) des signaux composites A et B (A et B enfoncés simultanément), d'une source externe (bouton EXT ou EXT ÷ 10 enfoncé) ou d'une tension interne à la fréquence secteur (boutons EXT et EXT ÷ 10 enfoncés).
Le conformateur d'impulsions de déclenchement est un multivibrateur à double commande commuté par les signaux de sortie d'un amplificateur différentiel.
Le signal de déclenchement, est appliqué aux entrées de l'amplificateur différentiel de concert avec les tensions continues réglables avec le potentiomètre LEVEL.
En fonction du réglage LEVEL, une certaine partie du signal de déclenchement est amplifiée par l'amplificateur différentiel.
Le multivibrateur est donc commuté à un point fixe du signal de déclenchement (voir Fig. 2.4.). Ceci signifie que, s'aidant de la commande LEVEL. il est possible de donner sa forme au signal de déclenchement (en cas de déclenchement interne A ou B égal à la forme du signal à représenter) et donc, de choisir le point où le multivibrateur sera commuté.
Le potentiomètre LEVEL est pourvu d'un commutateur push-pull qui permet la sélection de la pente de déclenchement.

3.6.3. Déclenchement automatique

Lorsque le bouton AUTO du commutateur AUTO-TRIG-SINGLE est enfoncé, et qu'aucune impulsion de déclenchement n'est disponible, le générateur de base de temps fonctionne librement.
La trace est alors toujours visible. Le mode AUTO peut être utilisé dans tous les cas où le mode TRIG est également applicable, à l'exception de signaux dont la fréquence est inférieure à 10 Hz et de trains d'impulsions ayant un temps supérieur à 100 ms.
Dès que des impulsions de déclenchement sont disponibles, le fonctionnement libre du générateur de base de temps est automatiquement achevé et le générateur est à nouveau déclenché comme décrit aux paragraphes 2.2.4.1. et 2.2.4.2.
Lorsque les boutons TRIG ou SINGLE sont actionnés, le circuit automatique est mis hors circuit. Le réglage LEVEL peut également être utilisé en mode AUTO.

3.6.4. Déclenchement du balayage en SINGLE

Lorsque des effets uniques sont observés (par photographie), il faut s'assurer qu'une seule dent de scie est engendrée, même si plusieurs impulsions de déclenchement doivent être produites après le phénomène en question. Il va de soi que la dent de scie simple en question doit être déclenchée par une impulsion de déclenchement. Pour ce faire, le bouton SINGLE doit être enfoncé. La première impulsion de déclenchement apparaissant après le relâchement du bouton démarre le générateur de base de temps. Celui-ci est alors bloqué jusqu'à ce que le bouton SINGLE soit enfoncé à nouveau. La lampe NOT TRIG'D s'allume dès que le bouton SINGLE est enfoncé et reste allumé et ce jusqu'à la fin de la dent de scie.

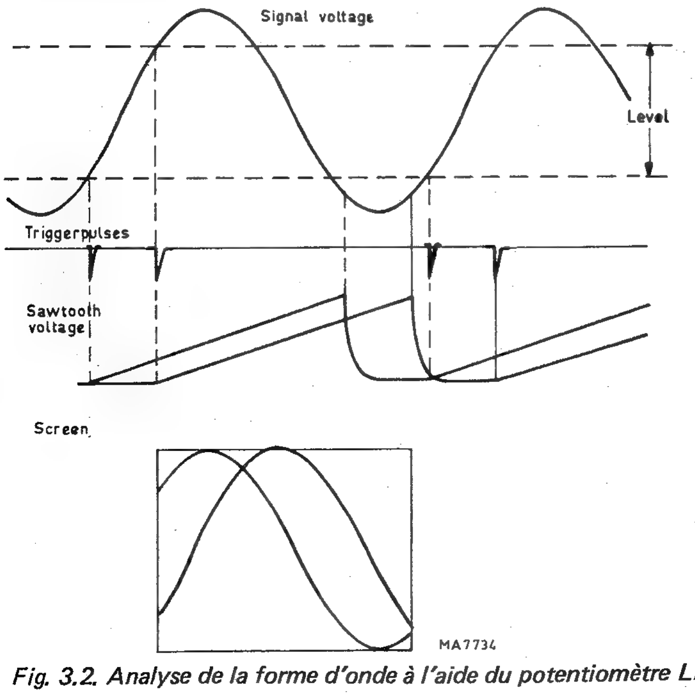


Fig. 3.2. Analyse de la forme d'onde à l'aide du potentiomètre LEVEL

3.7. AGRANDISSEUR DE BASE DE TEMPS MAGN (R2/S3)

L'agrandisseur de base de temps est actionné par un commutateur push-pull à deux positions incorporé dans la commande POSITION horizontale. Lorsque ce commutateur est tiré en position X10, les vitesses de balayage du générateur de base de temps principale sont augmentées d'un facteur 10. Donc, en X1, (TB MAGN enfoncé) la portion du signal affichée sur une largeur égale à une division au centre de l'écran occupe la largeur totale de l'écran en position X10. Chaque portion de la trace peut être rapportée sur l'écran à l'aide de la commande de POSITION horizontale.
En position X10, le coefficient de temps est déterminé en divisant par 10 la valeur TIME/DIV.

3.8. UTILISATION DE LA BASE DE TEMPS RETARDEE

La base de temps retardée peut servir à l'étude précise de signaux complexes. Lorsque le bouton-poussoir MAIN TB des commandes de la source de déclenchement (S21) de la base de temps retardée est actionné, la base de temps retardée est en service (par ex. commutateur TIME/DIV en position OFF), une portion de signal représenté est intensifiée en position MAIN TB des commandes de déviation horizontale (S2). La commande DELAY TIME permet de décaler cette partie intensifiée le long de l'axe des temps. La durée de cette portion intensifiée ainsi que sa longueur peuvent être commandées par échelons et ce de façon continue à l'aide des commandes TIME/DIV du générateur de base de temps retardée. Lorsque le bouton-poussoir DEL'D TB des commandes de déviation horizontale est enfoncé, la portion intensifiée occupe la largeur totale de l'écran.
En position DEL'D TB, le retard (c.à.d. l'intervalle entre le point de démarrage de la base de temps principale et le point de démarrage de la base de temps retardée) est déterminé par les réglages des commandes TIME/DIV principales et de la commande DELAY TIME.

Au cas où une des autres commandes de la source de déclenchement (S21) est actionnée, la base de temps retardée est demarrée par la première impulsion de déclenchement apparaissant après le temps de retard sélectionné. Cette impulsion est délivrée par le générateur de base de temps retardée.
Cette impulsion de déclenchement est produite par l'impulsion de déclenchement du générateur de base de temps retardée. Cette position est utilisée pour éviter une instabilité de la base de temps, laquelle donne une représentation floue d'un détail. Cette instabilité peut faire partie du signal à analyser ou, pour des agrandissements extrêmes, être produite dans les circuits de base de temps.

3.9. UTILISATION DE LA BASE DE TEMPS ALTERNEE (S2)

Le PM 3266 est équipé d'une commutation d'affichage. De ce fait, l'utilisateur obtient un affichage simultané du signal sur les deux échelles de temps, l'un provenant de la base de temps principale et l'autre de la base de temps retardée.
Une portion de l'affichage de la base de temps principale peut être examinée en détail en allongeant l'intervalle de temps en question à l'aide de la base de temps retardée. Cette expansion est obtenue en sélectionnant un balayage plus rapide de la commande TIME/DIV de la base de temps retardée. Le positionnement de l'intervalle de temps est réglée par le potentiomètre DELAY TIME. La portion de signal détaillée par la base de temps retardée demeure portion intensifiée de l'affichage de base de temps principale. Ceci ne facilite pas seulement le détail lors du réglage, mais il sert aussi d'indication visuelle. L'observateur peut comparer directement le détail avec le signal total (peut être très complexe) sans devoir commuter entre MAIN TB et DEL'D TB. Le décadrage vertical entre les deux affichages de base de temps est continûment variable à l'aide de la commande TRACE SEP (R6).

3.10. UTILISATION DE LA TROISIEME VOIE TRIGGER VIEW

3.10.1. Déclenchement externe ou interne

Dans la plupart des applications telles que le déclenchement des signaux numériques ou de forme différente, il faut utiliser une source de déclenchement externe assurant des relations de temps appropriées et permettant de comparer le signal de déclenchement aux signaux de mesure. Lorsque le bouton-poussoir TRIG VIEW est enfoncé, le signal de déclenchement externe à la douille d'entrée X7 est affiché en tant que troisième voie avec le seuil approchant la ligne de graticule centrale horizontale. Avec la commande LEVEL/SLOPE (R7, S7) il est facile de déterminer quelle partie du signal de déclenchement démarre le balayage. Ceci est également possible pour des signaux internes de la voie A ou B en enfonçant le bouton-poussoir A ou B du commutateur S22.
La commande de sensibilité du mode TRIG VIEW externe présente deux échelons à savoir 100 mV/DIV et 1 V/DIV.
Lorsque le bouton-poussoir EXT (S22) est enfoncé, le facteur de déviation est de 100 mV/DIV, ce qui est compatible aux niveaux ECL.
En mode EXT/10 (S22), le facteur de déviation est de 1 V/DIV, ce qui est compatible aux niveaux TTL.

3.10.2. Déclenchement monocup

La commande LEVEL/SLOPE (R7, S7) permet de régler le niveau de déclenchement sur une valeur pré-déterminée sans signal d'entrée. Ceci est d'importance lorsque le signal à mesurer n'est pas disponible à l'avance, par exemple lorsque du test de phénomènes uniques. Si des signaux d'entrée dépassant un seuil connu doivent être représentés, le niveau de déclenchement peut être réglé à l'avance (R7, S7) et un signal d'entrée d'amplitude suffisante démarre le balayage de base de temps.
Le procédé de réglage du niveau de déclenchement a lieu comme suit: Enfoncer le bouton-poussoir TRIG VIEW. Positionner la trace à l'aide de LEVEL (R7) autant de divisions en sens opposé nécessaires au seuil de déclenchement requis.

Remarque: Le seuil de déclenchement est défini comme la distance entre le point de déclenchement et la ligne zéro de l'amplificateur (par exemple sans signaux d'entrée et déviation à l'aide des commandes position).

3.11. UTILISATION DES FONCTIONS DE MEMOIRE

Mode MEMORY OFF

Lorsque les boutons STORE et WRITE sont enfoncés, la fonction de mémoire est mise hors service et l'appareil fonctionne comme un oscilloscope normal. Le bouton INTENS commande la luminosité de l'onde affichée. De plus, le bouton FOCUS doit être réglé sur netteté maximale de l'onde affichée.

Blocage du système de mémoire. Si l'appareil est en position d'attente en mode FAST (après le cycle ERASE), pour balayage de base de temps, l'instrument ne peut être utilisé qu'en mode MEMORY OFF et pas en mode WRITE ou STORE. L'instrument peut être mis en mode WRITE ou STORE si le cycle complet effacement/écriture est terminé. En d'autres mots seulement après fonctionnement de la base de temps et réalisation du transfert d'image.

ATTENTION: En position MEMORY OFF, spécialement en EXT X DEFL, une trop forte intensité pendant un certain temps peut endommager le TRC.
L'onde est enrigistrée à vitesse normale. La position de la commande INTENS détermine l'intensité de l'onde écrite sur la couche memoire du TRC

Mode WRITE

En fonction de la position du potentiomètre PERSISTENCE, une trace à disparition rapide est écrite sur fond vert (bouton en position extrême gauche) et une trace à disparition très lente sur fond noir (bouton en position "premier arrêt droite"), La persistance peut être réglée de telle sorte que tout clignotement est supprimé à la représentation d'un signal basse fréquence. Pour un signal à faible taux de répétition et court temps de montée, la persistance peut être réglée pour remplir la trace et donc obtenir une représentation nette et constante. La vitesse d'écriture peut être accrue d'un facteur 10 en mettant la commande PERSISTENCE en position MAX.

Mode FAST

L'onde est enregistrée à grande vitesse d'écriture. La position de la commande INTENS détermine l'intensité de l'onde écrite sur la couche mémoire du TRC.
Il s'agit d'un mode monocoup. Si la commande VIEW TIME n'est pas en position MAX, le cycle suivant est réalisé à répétition. L'image mémorisée est effacée et une nouvelle image écrite lorsque la base de temps est déclenchée. Après un temps de visualisation réglable, le cycle suivant commence à effacer l'écran TRC. Ce temps est réglable à l'aide de la commande VIEW TIME, entre 3 secondes (position extrême gauche) et 8 secondes (premier arrêt droit). Si le bouton VIEW TIME est en position MAX, l'enregistrement d'une nouvelle image n'a lieu qu'après que le bouton ERASE ait été enfoncé. Dans ce mode, il est également possible du choisir le mode STORE après fonctionnement de la base de temps et écriture d'un nouvelle image.
Pour cette fonction, procéder comme suit: mettre l'instrument en mode FAST et effacer l'image.
Ensuite, l'appareil attend un signal de déclenchement.
Enfoncer le bouton STORE et l'appareil est en mode STORE après l'écriture d'une nouvelle image.
Pour obtenir une image de bonne qualité, un signal de déclenchement devra être donné dans la minute.
Du fait du processus de transfert d'image, le mode rapide ne convient pas si les vitesses de balayage de base de temps sont basses. Car, dans ce cas, la fin de la trace sera plus brillante que le début.

Mode STORE

Ce mode permet de mémoriser une onde enregistrée pour un temps prolongé. La commande INTENS est fonctionnelle: la commande sur le premier arrêt gauche donne un long temps de mémorisation (env. 1 heure). L'onde n'est pas visible dans cette position.
Avec la commande INTENS en position extrême droite, le temps de mémorisation est court: voir figures au chapitre "Caractéristiques". Dès lors l'onde est bien visible.
Le bouton ERASE n'est pas fonctionnel en mode STORE.

Mode ERASE

Lorsque la trace n'est plus nécessaire, elle peut être effacée en enfonçant le bouton ERASE (pas fonctionnel en mode STORE). Il se peut que la trace n'ait pas disparu entièrement et plus particulièrement les parties affichées avec luminosité substantielle. Ceci peut être corrigé avec un appui prolongé sur le bouton ERASE.

4. CONTROLE DU FONCTIONNEMENT

4.1. GENERALITES

Le but de ce contrôle est de vérifier les principales fonctions de l'oscilloscope en réduisant au minimum les phases et actions de test requises. On supposera que l'opérateur qui effectue ce test connaît bien cet oscilloscope et ses caractéristiques.

ATTENTION: **Avant de le mettre sous tension, vérifier que l'oscilloscope à été installé conformément aux indications figurant dans le chapitre 2.**

Si ce test commence quelques minutes après la mise sous tension, n'oublier pas que le résultat de certaines phases de test sortira des spécifications du fait d'un temps de préchauffage trop court.
Pour que de tels cas ne se produisent pas, respecter strictement le temps de préchauffage mentionné. Le test doit être effectué à une température ambiante de 20 ... 30°C.
Les valeurs de mesure qui doivent être contrôlées sond indiquées sans tolérance et correpondent aux caractéristiques d'un appareil de moyen: pour les tolérances, voir le chapitre 1.2. "Caractéristiques". Les contrôles sont effectuées à l'aide du générateur de tension d'étalonnage interne de l'appareil.

ATTENTION: **Employer l'intensité minimale sur l'écran pour produire un trace bien définié.
Une trop forte intensité pendant un certain temps peut endommager le système mémoire du TRC.**

4.2. POSITIONS DE DEPART DES COMMANDES

- Sélectionner le mode MEMORY OFF (arrêt mémoire): appuyer sur les touches STORE (stockage) et WRITE (écriture) du sélecteur de mode de mémoire S24.
- Appuyer sur la touche AUTO du sélecteur de mode de déclenchement S8.
- Appuyer sur la touche ALT du sélecteur de mode d'affichage vertical S1.
- Placer les commutateurs de voie A et B AMPL/DIV S9 et S11 en position 0,5V/DIV et leurs verniers R8/S10 et R9/S12 en position CAL.
- Après les avoir placés en position intermédiaire, appuyer sur les commandes de POSITION de voie A et B R3/S4 et R4/S5.
- Placer les commandes de couplage de signal AC/O/DC des voies A et B S17 et S18 en position O.
- Placer le commutateur de base de temps principale TIME/DIV S15 en position 0,1ms/DIV et son vernier R11/S16 en position CAL.
- Placer le commutateur de base de temps retardée TIME/DIV S13 en position ARRET (OFF) et son vernier R10/S14 en position CAL.
- Appuyer sur la touche MAIN TB (base de temps principale) du sélecteur de mode d'affichage horizontal S2.
- Après l'avoir placée en position intermédiaire, appuyer sur la commande POSITION horziontale R2.
- Appuyer sur les touches DC des sélecteurs de couplage de déclenchement MAIN TB (base de temps principale) et DEL'D TB) (base de temps retardée), S19 et S20.

4.3. SECTION AFFICHAGE DU TUBE CATHODIQUE

- Régler le commandes INTENS et FOCUS (concentration) R14 et R17 pour obtenir une image nette. Lors de ces contrôles, il peut s'avérer nécessaire de réajuster les commandes.
- Centrer les lignes de base de temps de la voie A et de la voie B à l'aide des potentiomètres POSITION R3, R4 et R2.
- Vérifier si les lignes de base de temps sont exactement parallèles aux lignes horizontales du réticule. Dans le cas contraire, réajuster la commande R15 TRACE ROTATION. On pourra accéder à cette commande, réglable à l'aide d'un tournevis, par un trou d'aération du panneau latéral gauche de l'instrument.

4.4. VOIES VERTICALES

- Le contrôle est indentique pour les voies A et B. Les boutons, prises et éléments de réglage de la voie B sont indiqués entre parenthèses après ceux de la voie A.
- Placer le commutateur de base de temps principale TIME/DIV en position 50ms/DIV et vérifier si les voies A et B sont affichées alternativement.
- Appuyer sur la touche CHOP (découpage) du sélecteur de mode d'affichage vertical et vérifier si les voies A et B semblent être affichées simultanément.
- Placer le commutateur de base de temps principale TIME/DIV en position 0,1ms/DIV.
- Appuyer sur la touche A (B) du sélecteur de mode d'affichage vertical: dès lors, seule la ligne de base de temps de la voie A (B) est visible.
- Appuyer sur la touche A (B) du sélecteur de source de déclenchement de la base de temps principale S22.
- Appliquer la tension de sortie provenant de la prise CAL X1/X2 à la prise d'entrée de la voie A (B) X3 (X4).
- Placer le commutateur de couplage du signal de la voie A (B) en position DC: le signal de sortie provenant de la prise CAL est désormais visible sur l'écran.
- Régler le niveau de base de temps principale de manière à inscrire une forme d'onde stable. La déviation verticale doit être de 6 divisions. Dans le cas contraire, réajuster à l'aide d'un tournevis le point de réglage du panneau avant R12 (R13).
- Vérifier également le sélecteur de FLANC de déclenchement (SLOPE) S7 intégré à la commande de NIVEAU (LEVEL) R7.
  Si la commande R7/S7 est tirée, la trace commence sur le flanc négatif du signal et, si la touche est enfoncée, le signal commence sur le flanc positif du signal.
- Le signal qui est affiché maintenant est une onde carée, le niveau inférieur se situant à 0V et le niveau supérieur à 3V. Le signal contient une composante continue de 1,5V. Lorsque le commutateur de couplage AC/O/DC est en position AC, la composante continue est bloquée et le signal est désormais symétrique par rapport au niveau 0V sur l'écran. Vérifier alors la position AC.
- Vérifier si le signal de la voie A (B) affiché sur l'écran est inversé lorsque l'on met en service la fonction PULL TO INVERT (tirer pour inverser), autrement dit si l'on tire la commande de POSITION A (B) S4/R3 (S5/R4).
- Appuyer une nouvelle fois sur la commande de POSITION de la voie A (B).
- Appuyer sur la touche EXT X DEFL du sélecteur de mode de déviation horizontale.
- Appuyer sur la touche A (B) du sélecteur de source de déclenchement de la base de temps principale.
- Appliquer la tension de sortie de la prise CAL à la prise d'entrée de la voie A (B).
- Appuyer sur la touche B (A) du sélecteur de mode de déviation verticale.
- Vérifier si deux des points affichés sont distants horizontalement de 6 divisions.

- Appuyer sur la touche TRIG VIEW (visualisation du déclenchement) du sélecteur de mode de déviation verticale.
- Appuyer sur la touche A (B) du sélecteur de source de déclenchement de la base de temps principale.
- Applquer la tension de sortie de la prise CAL à la prise d'entrée de la voie A (B).
- Appuyer sur la touche MAIN TB du sélecteur de mode de déviation horizontale.
- Vérifier si le signal affiché sur l'écran est une onde carrée de 6 divisions. Ce signal est décalé dans le sens vertical si l'on actionne la commande "LEVEL" de la base de temps principale.

4.5. BASES DE TEMPS ET DECLENCHEMENT

- Appuyer sur la touche A (B) du sélecteur de mode d'affichage vertical.
- Appliquer le signal de sortie de la prise CAL à la prise d'entrée de la voie A (B).
- Appuyer sur la touche A (B) du sélecteur de source de déclenchement de la base de temps principale.
- Placer le commutateur TIME/DIV de la base de temps principale en position 0,1ms/DIV.
- Appuyer sur la touche MAIN TB du sélecteur de mode d'affichage horizontal.
- Régler la commande de niveau (LEVEL) de la base de temps principale pour un affichage déclenché.
- Tirer le bouton TB MAGN R2/S3, intégré à la commande de POSITION horizontale et veréfier si la déviation horizontale est multipliée par 10.
- Appuyer une nouvelle fois sur le bouton TB MAGN.
- Appuyer sur la touche SINGLE du sélecteur de mode de déclenchement S8. Vérifier si la base de temps principale ne défile qu'une fois lorsque l'on relâche cette touche.

- Appuyer une nouvelle fois sur la touche AUTO du sélecteur de mode de déclenchement.
- Placer la commande TIME/DIV de base de temps rétardée S13 en position 20 μs/DIV et son vernier R10/S14 en position CAL.
- Appuyer sur la touche MAIN TB du sélecteur de source de déclenchement de la base de temps retardée S21.
- Vérifier si un tronçon surintensifié est visible sur le signal de base de temps principale et si l'on peut déplacer ce tronçon sur la ligne de base de temps principale à l'aide de la commande DELAY TIME(temps de retardement) R1.
  Si nécessaire, réajuster la commande INTENS pour obtenir un meilleur rapport d'intensité entre le signal de base de temps principale et le tronçon surintensifié.
- Appuyer sur la touche DELD TB (base de temps retardée) du sélecteur de mode d'affichage horizontal et vérifier si le tronçon surintensifié couvre maintenant toute la largeur de l'écran.
- Appuyer sur la touche ALT TB (base de temps alternée) du sélecteur de mode d'affichage horizontal.
  Le signal de base de temps principale avec tronçon surintensifié et le tronçon surintensifié affiché sur toute la largeur de l'écran doivent alors être affichés en même temps.
  Le décalage vertical entre les deux affichages doit être réglabe à l'aide de la commande de séparation de trace (TRACE SEP) R6.
- Appuyer sur la touche MAIN TB du sélecteur de mode d'affichage horizontal.
- Appuyer sur la touche A (B) du sélecteur de source de déclenchement de la base de temps retardée.
- Régler la commande de niveau de la base de temps retardée (LEVEL) R5 pour que le tronçon surintensifié soit visible sur le signal de base de temps principale. Vérifier également le fonctionnement du commutateur SLOPE (flanc de déclenchement) S6, incorporé à la commande de niveau LEVEL.

4.6. FONCTIONS DE MEMOIRE

- Appuyer sur la touche A du sélecteur de mode d'affichage vertical.
- Appliquer la tension de sortie de la prise CAL à la prise d'entrée de la voie A.
- Placer le commutateur de base de temps retardée TIME/DIV en position OFF (arrêt).
- Appuyer sur la touche A du sélecteur de source de déclenchement de la base de temps principale.
- Appuyer sur la touche MAIN TB du sélecteur de déviation horizontale S2.
- Régler la commande de niveau LEVEL de base de temps principale afin d'obtenir un affichage déclenché sur l'écran.
- Appuyer sur la touche SINGLE du sélecteur de mode de déclenchement.

- Tourner à fond dans le sens anti-horaire la commande de PERSISTANCE (PERSISTENCE) R16/S26.
- Appuyer sur la touche d'écriture WRITE du sélecteur de mode de mémoire S24: l'écran présente alors un fond vert illuminé.
- Si l'on actionne la touche ERASE (effacement) S25, une forme d'onde est écrite: le temps de persistance de cette forme d'onde doit augmenter si l'on tourne la commande PERSISTENCE dans le sens horaire, vers sa première butée. En même temps, l'éclairage du fond doit diminuer.
- Placer la commande de PERSISTANCE en position MAX: on doit alors pouvoir constater un certain éclairage du fond.
- Ecrire une forme d'onde et appuyer sur la touche STORE du sélecteur de mode de mémoire. Vérifier si, dans ce mode, la luminosité du signal est réglable à l'aide de la commande INTENS.

- Appuyer sur la touche FAST (rapide) du sélecteur de mode de mémoire et vérifier si une forme d'onde peut être écrite.
  Une forme d'onde est écrite si l'on actionne le bouton ERASE (effacement) et que la commande VIEW TIME (temps de visualisation) R16/S26 est en position MAX.
- Tourner la commande VIEW TIME en deça de sa position MAX.
  Le cycle d'effacement et d'écriture démarre désormais automatiquement, l'intervalle entre les cycles étant réglables: cet intervalle doit être court si la commande VIEW TIME est tournée à fond dans le sens anti-horaire, et doit augmenter si l'on tourne cette commande dans le sens horaire, en direction de sa première butée.

- Appuyer une nouvelle fois sur la touche AUTO du sélecteur de mode de déclenchement.
- Placer la commande TIME/DIV de base de temps rétardée S13 en position 20 µs/DIV et son vernier R10/S14 en position CAL.
- Appuyer sur la touche MAIN TB du sélecteur de source de déclenchement de la base de temps retardée S21.
- Vérifier si un tronçon surintensifié est visible sur le signal de base de temps principale et si l'on peut déplacer ce tronçon sur la ligne de base de temps principale à l'aide de la commande DELAY TIME(temps de retardement) R1.
  Si nécessaire, réajuster la commande INTENS pour obtenir un meilleur rapport d'intensité entre le signal de base de temps principale et le tronçon surintensifié.
- Appuyer sur la touche DELD TB (base de temps retardée) du sélecteur de mode d'affichage horizontal et vérifier si le tronçon surintensifié couvre maintenant toute la largeur de l'écran.
- Appuyer sur la touche ALT TB (base de temps alternée) du sélecteur de mode d'affichage horizontal.
  Le signal de base de temps principale avec tronçon surintensifié et le tronçon surintensifié affiché sur toute la largeur de l'écran doivent alors être affichés en même temps.
  Le décalage vertical entre les deux affichages doit être réglabe à l'aide de la commande de séparation de trace (TRACE SEP) R6.
- Appuyer sur la touche MAIN TB du sélecteur de mode d'affichage horizontal.
- Appuyer sur la touche A (B) du sélecteur de source de déclenchement de la base de temps retardée.
- Régler la commande de niveau de la base de temps retardée (LEVEL) R5 pour que le tronçon surintensifié soit visible sur le signal de base de temps principale. Vérifier également le fonctionnement du commutateur SLOPE (flanc de déclenchement) S6, incorporé à la commande de niveau LEVEL.

4.6. FONCTIONS DE MEMOIRE

- Appuyer sur la touche A du sélecteur de mode d'affichage vertical.
- Appliquer la tension de sortie de la prise CAL à la prise d'entrée de la voie A.
- Placer le commutateur de base de temps retardée TIME/DIV en position OFF (arrêt).
- Appuyer sur la touche A du sélecteur de source de déclenchement de la base de temps principale.
- Appuyer sur la touche MAIN TB du sélecteur de déviation horizontale S2.
- Régler la commande de niveau LEVEL de base de temps principale afin d'obtenir un affichage déclenché sur l'écran.
- Appuyer sur la touche SINGLE du sélecteur de mode de déclenchement.

- Tourner à fond dans le sens anti-horaire la commande de PERSISTANCE (PERSISTENCE) R16/S26.
- Appuyer sur la touche d'écriture WRITE du sélecteur de mode de mémoire S24: l'écran présente alors un fond vert illuminé.
- Si l'on actionne la touche ERASE (effacement) S25, une forme d'onde est écrite: le temps de persistance de cette forme d'onde doit augmenter si l'on tourne la commande PERSISTENCE dans le sens horaire, vers sa première butée. En même temps, l'éclairage du fond doit diminuer.
- Placer la commande de PERSISTANCE en position MAX: on doit alors pouvoir constater un certain éclairage du fond.
- Ecrire une forme d'onde et appuyer sur la touche STORE du sélecteur de mode de mémoire. Vérifier si, dans ce mode, la luminosité du signal est réglable à l'aide de la commande INTENS.

- Appuyer sur la touche FAST (rapide) du sélecteur de mode de mémoire et vérifier si une forme d'onde peut être écrite.
  Une forme d'onde est écrite si l'on actionne le bouton ERASE (effacement) et que la commande VIEW TIME (temps de visualisation)R16/S26 est en position MAX.
- Tourner la commande VIEW TIME en deça de sa position MAX.
  Le cycle d'effacement et d'écriture démarre désormais automatiquement, l'intervalle entre les cycles étant réglables: cet intervalle doit être court si la commande VIEW TIME est tournée à fond dans le sens anti-horaire, et doit augmenter si l'on tourne cette commande dans le sens horaire, en direction de sa première butée.

5. ENTRETIEN PREVENTIF

5.1. GENERALITES

Le présent appareil ne requiert en principe aucune maintenance, car il ne contient pas de composants sujets à l'usure. Cependant, pour garantir le fonctionnement fiable et sans défaillances, l'appareil ne doit pas être exposé à l'humidité, le chaleur, des éléments corrosifs ou la poussière excessive.

5.2. NETTOYAGE DU REVETEMENT SUEDE NEXTEL

ATTENTION: Le revêtement suède NEXTEL résistance à l'éthanol, pas à l'alcool à brûler: la décomposition d'une des substances endommagerait le revêtement NEXTEL de façon irréparable.

Au bout d'un certain temps, le revêtement suède NEXTEL perd de son éclat. Un nettoyage régulier de la surface à l'aide d'un chiffon humide (eau, éthanol ou autre détergent) ne donnera pas le résultat escompté.
La surface frottée par un chiffon sera nettoyée, non les granulations et les griffes.

3M-COMPANY a développé une nouvelle méthode de nettoyage permettant le nettoyage des granulations. L'éponge no. 8840 de 3M doit être trempée dans l'eau, l'éthanol ou un détergent courant. Il s'agit d'un chiffon ayant les mêmes propriétés que les éponges ou les chiffons abrasifs: il nettoie les surfaces et leur redonne l'éclat sans toutefois les griffer.

5.3. RE-ETALONNAGE

La pratique a prouvé que l'oscilloscope fonctionne dans les limites spécifiés pendant une période de 1000 heures de travail ou de 6 mois en cas d'usage irrégulier.
De plus, le remplacement de composants peut nécessiter un ré-étalonnage des circuits affectés. Les procédés de contrôle et d'ajustage peuvent également servir à détecter certaines fautes dans l'appareil.
Dans certains cas, des troubles mineurs peuvent être localisés et/ou corrigés par le ré-étalonnage. Les instructions complètes de contrôle et d'ajustage sont mentionnées au chapitre "Contrôles et réglages".

Service Manual

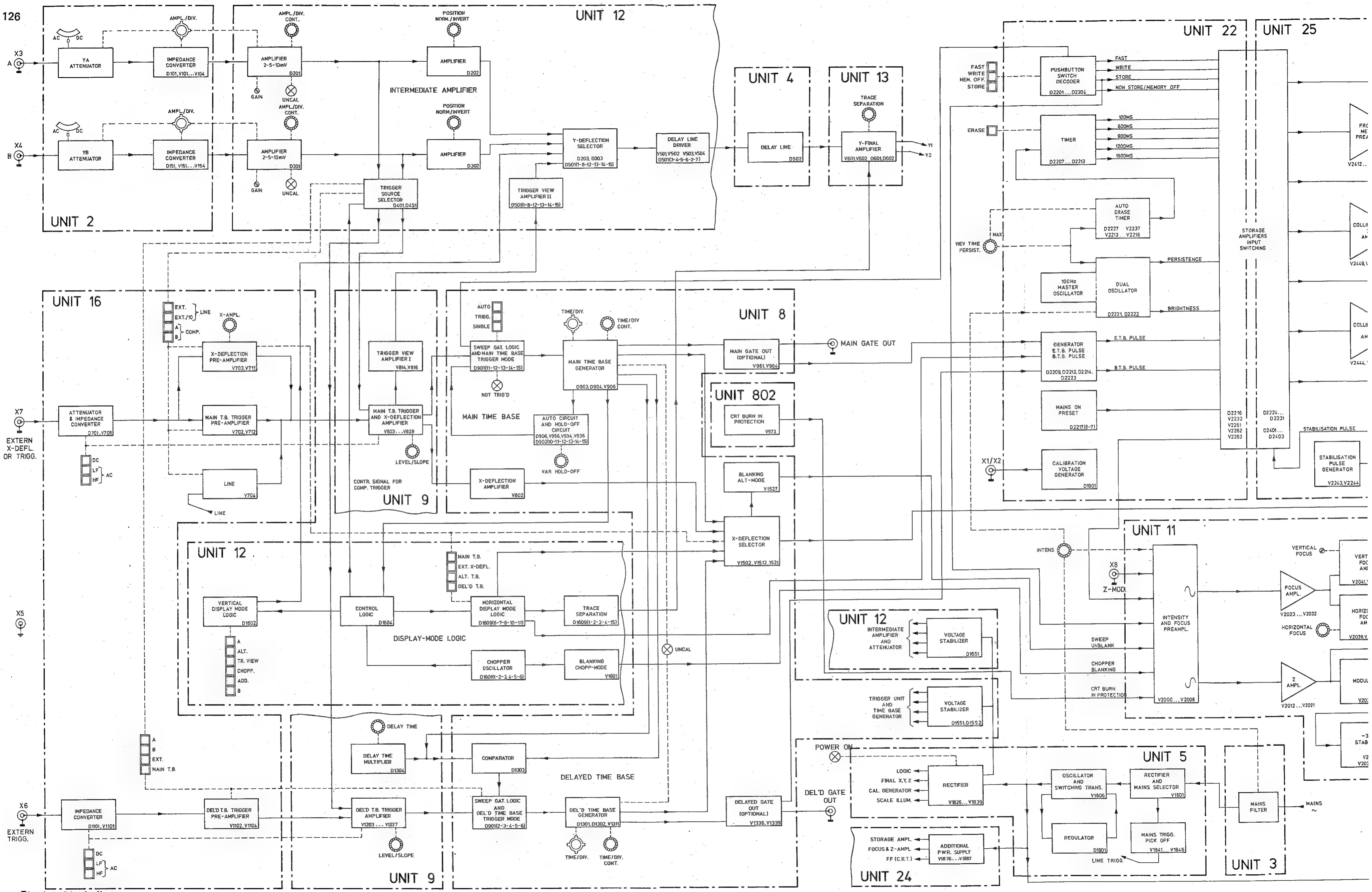
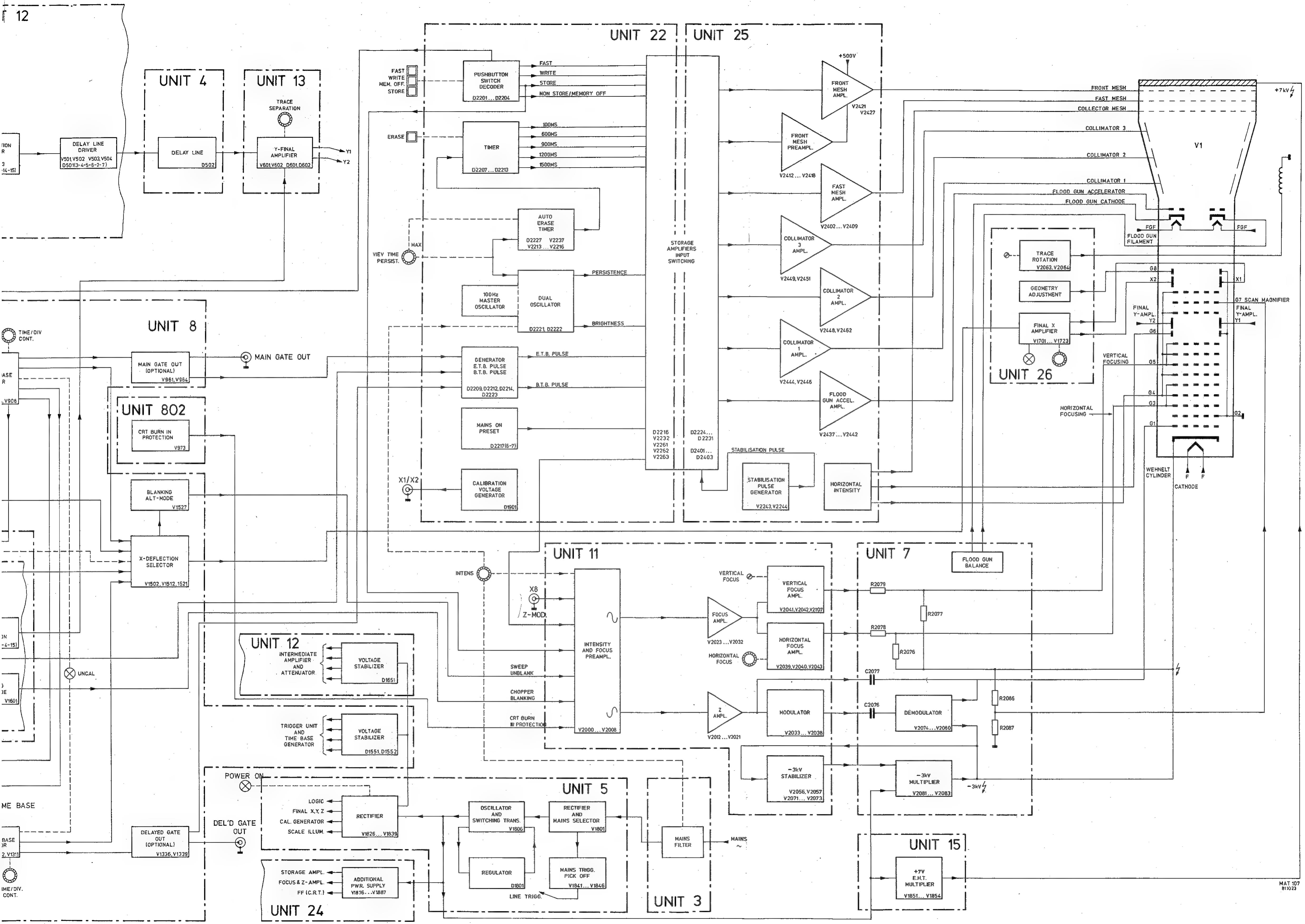


Fig. 6.1. Block diagram


UNIT 12
UNIT 4
DELAY LINE
D502
UNIT 13
TRACE SEPARATION
Y-FINAL AMPLIFIER
V601,V602 D601,D602
Y1
Y2
DELAY LINE DRIVER
V501,V502 V503,V504
D501(3-4-5-6-2-7)
UNIT 22
UNIT 25
FAST
WRITE
MEM. OFF.
STORE
PUSHBUTTON SWITCH DECODER
D2201 ... D2204
NON STORE/MEMORY OFF
ERASE
TIMER
D2207 ... D2213
100MS
600MS
900MS
1200MS
1500MS
AUTO ERASE TIMER
D2227 V2237
V2213 ... V2216
VIEW TIME PERSIST.
MAX
PERSISTENCE
100Hz MASTER OSCILLATOR
DUAL OSCILLATOR
D2221, D2222
BRIGHTNESS
GENERATOR E.T.B. PULSE B.T.B. PULSE
D2209, D2212, D2214, D2223
E.T.B. PULSE
B.T.B. PULSE
MAINS ON PRESET
D2217(6-7)
X1/X2
CALIBRATION VOLTAGE GENERATOR
D1901
STORAGE AMPLIFIERS INPUT SWITCHING
D2216
V2232
V2261
V2262
V2263
D2224 ... D2231
D2401 ... D2403
+500V
FRONT MESH AMPL.
V2421
V2427
FRONT MESH PREAMPL.
V2412 ... V2418
FAST MESH AMPL.
V2402 ... V2409
COLLIMATOR 3 AMPL.
V2449, V2451
COLLIMATOR 2 AMPL.
V2448, V2462
COLLIMATOR 1 AMPL.
V2444, V2446
FLOOD GUN ACCEL. AMPL.
V2437 ... V2442
STABILISATION PULSE
STABILISATION PULSE GENERATOR
V2243, V2244
HORIZONTAL INTENSITY
FRONT MESH
FAST MESH
COLLECTOR MESH
COLLIMATOR 3
COLLIMATOR 2
COLLIMATOR 1
FLOOD GUN ACCELERATOR
FLOOD GUN CATHODE
FGF
FLOOD GUN FILAMENT
+7kV
V1
TRACE ROTATION
V2063, V2064
GEOMETRY ADJUSTMENT
FINAL X AMPLIFIER
V1701 ... V1723
UNIT 26
G8
X2
X1
G7 SCAN MAGNIFIER
FINAL Y-AMPL.
Y2
Y1
G6
G5
VERTICAL FOCUSING
HORIZONTAL FOCUSING
G4
G3
G2
G1
WEHNELT CYLINDER
F
CATHODE
TIME/DIV CONT.
UNIT 8
MAIN GATE OUT (OPTIONAL)
V961, V954
MAIN GATE OUT
UNIT 802
CRT BURN IN PROTECTION
V973
BLANKING ALT-MODE
V1527
X-DEFLECTION SELECTOR
V1502, V1512, 1521
UNCAL
UNIT 11
INTENS
X8
Z-MOD.
INTENSITY AND FOCUS PREAMPL.
V2000 ... V2008
SWEEP UNBLANK
CHOPPER BLANKING
CRT BURN IN PROTECTION
VERTICAL FOCUS
FOCUS AMPL.
V2023 ... V2032
VERTICAL FOCUS AMPL.
V2041, V2042, V2107
HORIZONTAL FOCUS AMPL.
V2039, V2040, V2043
HORIZONTAL FOCUS
Z AMPL.
V2012 ... V2021
MODULATOR
V2033 ... V2038
-3kV STABILIZER
V2056, V2057
V2071 ... V2073
UNIT 7
FLOOD GUN BALANCE
R2079
R2077
R2078
R2076
C2077
C2076
DEMODULATOR
V2074 ... V2080
R2086
R2087
-3kV MULTIPLIER
V2081 ... V2083
-3kV
UNIT 12
INTERMEDIATE AMPLIFIER AND ATTENUATOR
VOLTAGE STABILIZER
D1651
TRIGGER UNIT AND TIME BASE GENERATOR
VOLTAGE STABILIZER
D1551, D1552
ME BASE
DELAYED GATE OUT (OPTIONAL)
V1336, V1339
DEL'D GATE OUT
POWER ON
UNIT 5
LOGIC
FINAL X, Y, Z
CAL. GENERATOR
SCALE ILLUM.
RECTIFIER
V1826 ... V1839
OSCILLATOR AND SWITCHING TRANS.
V1806
RECTIFIER AND MAINS SELECTOR
V1801
REGULATOR
D1801
MAINS TRIGG. PICK OFF
V1841 ... V1846
LINE TRIGG.
MAINS FILTER
MAINS
UNIT 3
STORAGE AMPL.
FOCUS & Z-AMPL.
FF (C.R.T.)
ADDITIONAL PWR. SUPPLY
V1876 ... V1887
UNIT 24
UNIT 15
+7V E.H.T. MULTIPLIER
V1851 ... V1854
MAT 107
811023

6. CIRCUIT DESCRIPTION

6.1. BLOCK DIAGRAM DESCRIPTION AND STORAGE CRT PRINCIPLES

6.1.1. Introduction

The block diagram is shown in Fig. 6.1.

The PM 3266 oscilloscope comprises the following parts:

- a dual-channel vertical system
- a main time-base
- a delayed time-base
- a display-mode logic stage
- an X-amplifier
- a Z-stage
- a c.r.t. circuit
- the storage section
- a stabilized power supply

6.1.2. Dual-channel vertical system

Both vertical channels contain identical circuits. An input signal to one of the channels is, via a coupling switch AC/0/DC, applied to the input attenuator. In the AC position of the coupling switch there is a capacitor in the signal path. In the DC position the coupling is direct.
If the coupling switch is set to the 0 position, the connection between the input socket and the attenuator input is interrupted, the latter being earthed.

The input attenuator, which is controlled by the AMPL switch, enables the adjustment of the vertical-deflection sensitivity in calibrated steps.

The attenuator is followed by a low-drift impedance converter which gives the input circuit a high input impedance.
The impedance converter also contains a voltage divider which works in conjunction with the input attenuator.

The signal that leaves the impedance converter is applied to a balanced amplifier (D201-Y_A, D301-Y_B) where it is transformed into a push-pull signal. The balanced amplifier has two outputs. From one of these outputs the signals are applied to a trigger selector stage and from the other one to an amplifier stage (D202-Y_A, D302-Y_B).
This stage comprises the switch NORMAL/INVERT by means of which the phase of the signal can be inverted, and the controls for vertical trace positioning.

The following stage is a channel selector which either blocks or passes the signal as dicated by the vertical display-mode logic and switches.
In the A, B, ADD and TRIG VIEW modes the channel selector is set by means of voltage levels (via the display-logic stage) and in the ALT and CHOP mode controlled by pulses (also via the display-mode logic stage). In the ALT mode those pulses are supplied by the sweep-gating multivibrator of the main time-base generator during the fly back of the sweep, so that alternately the complete signals of channel A, channel B and the 3rd channel TRIG VIEW are displayed.
In the CHOP mode the drive pulses are provided by an oscillator which works at a fixed frequency of approximately 1 MHz.
Those pulses cause the electronic switches in the display-mode logic stage to be successively opened and closed so that successively part of the signal of channel A, channel B and the 3rd channel TRIG VIEW are displayed.

After the channel selector, the following circuits are common to the vertical channels.
A delay line that delayes the vertical signals to such an extent that the steep leading edges of fast signals are still displayed, a delay line driver stage and a final output stage which feeds the signals to the vertical-deflection plates.

6.1.3. Time bases

Main time-base

The M.T.B. trigger and X-Deflection amplifier receives its signal from one of the vertical channels or both (COMPOSITE), from the attenuator/impedance converter for external trigger or X deflection signals, or from the power supply (MAINS). One of those signals can be selected by operating one of the controls incorporate in this stage.

From this stage the signal is fed to either the X-Deflection amplifier for horizontal deflection, or the sweep-gating logic for starting the time-base generator. The MTB trigger and X-Deflection amplifier is a differential one, containing the controls for trigger-level adjustment, slope selection and coupling (i.e. DC/LF/HF) selection.

The slope selector allows the polarity of the trigger signal to be inverted, enabling triggering on the positive as well as on the negative slope of the input signals.

The sweep-gating logic starts and stops the time-base generator which delivers the sawtooth signal required for normal time-base operation. The generator comprises the charging capacitors and resistors selected by the TIME/DIV switch in order to set the time coefficients in calibrated steps. Continuous control of the time coefficients is obtained by varying the charging current of the time determining capacitors by means of the TIME/DIV continuous potentiometer.

The amplified output signal of the time-base generator is fed to the X deflection selector, the comparator which is part of the delayed time-base unit and via a feedback loop to the hold-off circuit. The hold-off circuit resets circuit resets the sweep-gating flip-flop (D901) and blocks its input during the flyback of the sawtooth signal. The hold-off circuit also incorporates the single-sweep circuit.

The three modes of operation of the main time-base are determined by the three-position switch AUTO/TRIGG/SINGLE.
In the AUTO mode, the automatic free-run circuit is operative when triggering pulses are absent. Thus a trace, though not necessarily a stationary one, is always displayed even though the trigger controls may not be correctly adjusted. In this way, correct adjustment of the oscilloscope trace is greatly facilitated. However, when trigger pulses are present the circuit reverts to the normal triggered mode. If trigger pulses disappear, the time-base free-runs after a lapse of approx. 100 ms. In the TRIGG. mode, a display is present only when suitable trigger pulses are available.
In the SINGLE mode, events that occur only once can be observed and photographed if necessary. It is often desirable to ensure that only one sweep is generated, even though other trigger pulses might follow the phenomenon of interest. In this mode, after the trigger pulse has initiated the main time-base to produce one sweep, the circuit is unaffected by further trigger pulses until it is reset for the next event by operating the reset push-button.

Delayed time-base

The delayed trigger-circuit and delayed time-base generator comprise in principle the same circuitry as the main trigger-circuit and main time-base generator. The delayed time-base works always in the single-shot mode. It is started by the main time-base generator which also serves as hold-off circuit for the delayed time-base.

The DELAY TIME multiplier control, the comparator and the reset multivibrator determine the delay time for the delayed time-base generator.

When push-button MAIN TB of the horizontal deflection mode controls has been depressed, the part of the trace coinciding with the delayed sweep is intensified, except in the OFF position of the delayed TIME/DIV switch.

6.1.4. X-Deflection selector

The X-deflection selector couples the external X-deflection signal, the output signal of the main time-base generator, the output signal of the delayed time-base generator or the combined output signals of the main and delayed time-base generators via the X-final amplifier, to the horizontal-deflection plates. The X-final amplifier comprises the horizontal trace positioning and 10x magnification controls.

The "alt-" and "chop"- mode stages supply blanking pulses to the Z amplifier. "Alt" pulses blank the trace at the end of the sweep of the main time-base and provide an extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. "Chop" pulses suppress the trace during the switching from channel Y_A to channel Y_B and/or the 3rd channel TRIG VIEW.

6.1.5. Storage system

6.1.5.1. Introduction

The PM3266 oscilloscope is equipped with a special storage tube, the principle of which is based upon the phenomena of secondary emission. The image that is required to be stored is written as a positive charge pattern into a storage mesh.

This mesh consists of a metal grid that is placed at a distance of a couple of millimetres behind the CRT screen. See fig. 6.2. The grid has apertures of about 40x40 micrometers. On the side of the grid that is adjacent to the writing system of the CRT, a layer of dielectric material is present. Capacitive coupling between this storage layer and the grid is essential for the storage and erase functions.

Wherever high energy electrons from the writing system strike the surface of the storage layer, a positive charge is generated because more electrons leave the layer than there were shot into it. This phenomena is known, as secondary emission.

Behind the storage mesh two flood gun systems are located. Both electrode systems send a cloud of low-energy electrons in the direction of the storage mesh. The flood gun electron cloud is shaped by collimators C1, C2 and C3 and accelerated by the collector mesh G10 in such a way that it evenly covers the storage mesh.

The low-energy electrons can only pass through the mesh towards the phosphor screen at places where the mesh is positively charged (provided that the metal grid is at a potential of 0V).
The electrons that pass the storage mesh are accelerated by the post accelerator voltage, which gives them so much energy that the phosphor screen emits light. In this way a replica of the waveform that was written into the storage layer is now visible on the screen.
So far the situation with one storage mesh has been discussed. The PM3266 storage tube however has two storage meshes.

Before considering the practical aspects of the PM3266 storage system, it is useful to discuss one of the important characteristics of storage layers, namely, capacitance.
Consider the two extreme cases:
- If the layer has a low capacitance, then signals with a high writing speed can be written in. i.e. information can be easily written in. However, a storage layer with this type of characteristic has the disadvantage that the charge pattern written-in leaks away fairly quickly:
  the storage time is short.
- If, on the other hand, the layer has a high capacitance, then only signals with a low writing speed can be written-in.
  An advantage of this type of layer is that charge patterns written-in persist for a reasonably long time.

A conventional storage tube only has a storage mesh of the high capacitance type. As stated the CRT of the PM3266 has two meshes:

- Directly behind the screen a high capacitance mesh is located that is used both in the WRITE and FAST mode. This mesh is called the front mesh.
- Behind the front mesh a low capacitance mesh is located. This mesh is called the fast mesh and is only used in the FAST mode.

In the FAST mode two meshes are used. First the image that is required to be stored is written into the fast mesh so that advantage can be taken from the high writing speed of this mesh. Because this mesh has a short storage time the charge pattern on it is transferred as quick as possible to the front mesh. This transfer occurs directly after the end of the time base sweep. Advantage can now be taken of the long storage time of the front mesh.

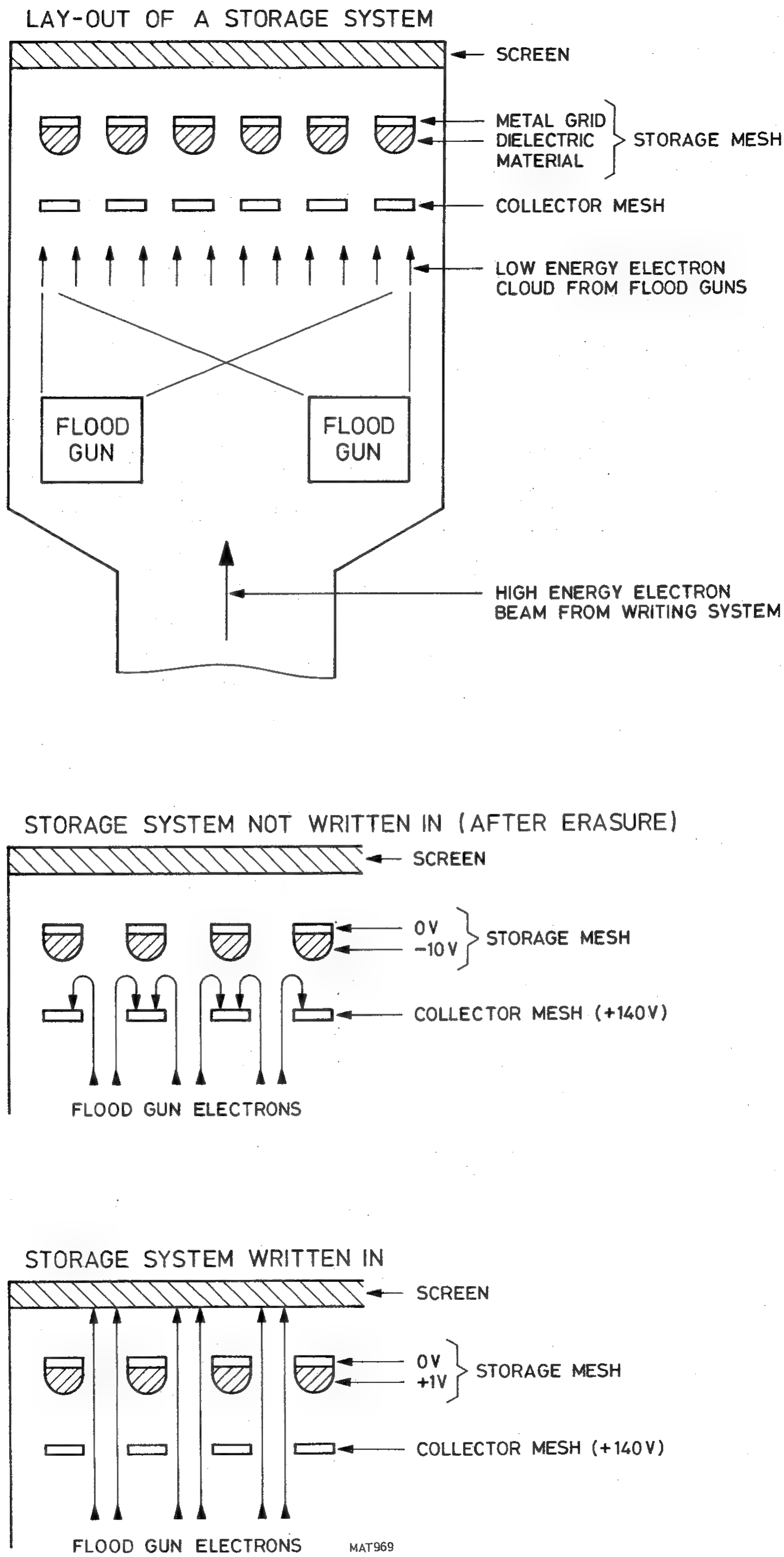


Fig. 6.2. Storage principles

In addition to the storage system, the writing system also has some interesting features. In order to obtain a reasonable vertical sensitivity a so called scan magnifier (G7) is added that gives a vertical gain increase of 1,8 times. The scan magnifier is an electrode system that is located between the vertical and horizontal deflection plates.
The scan magnifier gives the electron beam inside the CRT both a vertical divergence and a horizontal convergence. To correct for this the CRT has separate focusing electrodes for the vertical (G5) and horizontal (G3) directions.

6.1.5.2. *Write mode*

In this mode the fast storage mesh (G11) is not used and is connected to approximately the same potential as the collector mesh (G10): the fast mesh is connected to +140V and the collector mesh to +150V. The shape of the voltage waveforms applied to the remaining electrodes is indicated in timing diagram fig. 6.3.

Front mesh

At the moment that the ERASE pushbutton is released the first erase pulse is applied to the front mesh. This is a 500V/100ms pulse which erases the stored image.
The storage layer will follow the 500V potential of the grid because of capacitive coupling.
The surface is now bombarded by flood-gun electrons. Because of the accelerating influence of the 500V potential of the grid, these electrons have a high energy and secondary emission takes place over the whole surface of the storage layer. As a result; the entire storage layer becomes positive.
After the first erase pulse, the grid is returned to 0V for 500ms and the storage layer also returns to this potential after some time. The stored pattern has now been erased.
The second erase pulse that now follows, is a 10V/600ms pulse, which prepares the storage layer for a new writing-in cycle. When the pulse starts the storage layer follows the potential of the grid but the +10V level decays to 0V after some time because the storage layer captures flood-gun electrons.
At the end of the second erase pulse the grid potential falls from +10V to 0V and thus the storage layer; because of capacitive coupling falls from 0V to –10V. This –10V potential remains for a reasonable time (the storage time) and lies below the cut-off level of approx. –5V at which no electrons can pass the front mesh. First and second erase pulse are called the static erase pulses.
During these pulses and for 100ms, the time base is blocked so that writing in is then not possible.
Writing in: at places where high energy electrons from the writing system strike the storage layer the potential rises above the cut-off level due to secondary emission.
If the MAX WRITE mode is selected, the storage layer potential is made less negative than –10V after the second erase pulse: it lies closer to the cut-off level. Therefore, it takes less energy to write the storage layer in. As a result the writing speed has increased, but also some background illumination is visible. The less negative voltage of the storage layer is achieved as follows: after the second erase pulse, the grid jumps to a voltage that is somewhat higher than 0V.
In the VARIABLE PERSISTENCE mode, dynamic erase pulses are applied to the front mesh. When these pulses are high, flood-gun electrons are attracted and make the written in areas less positive. After a certain time, the cut-off level is reached and the written in charge pattern is erased.
The higher the duty cycle of the pulses, the quicker the stored information disappears.
During the erase cycle the collimators and the flood-gun accelerator are pulsed.

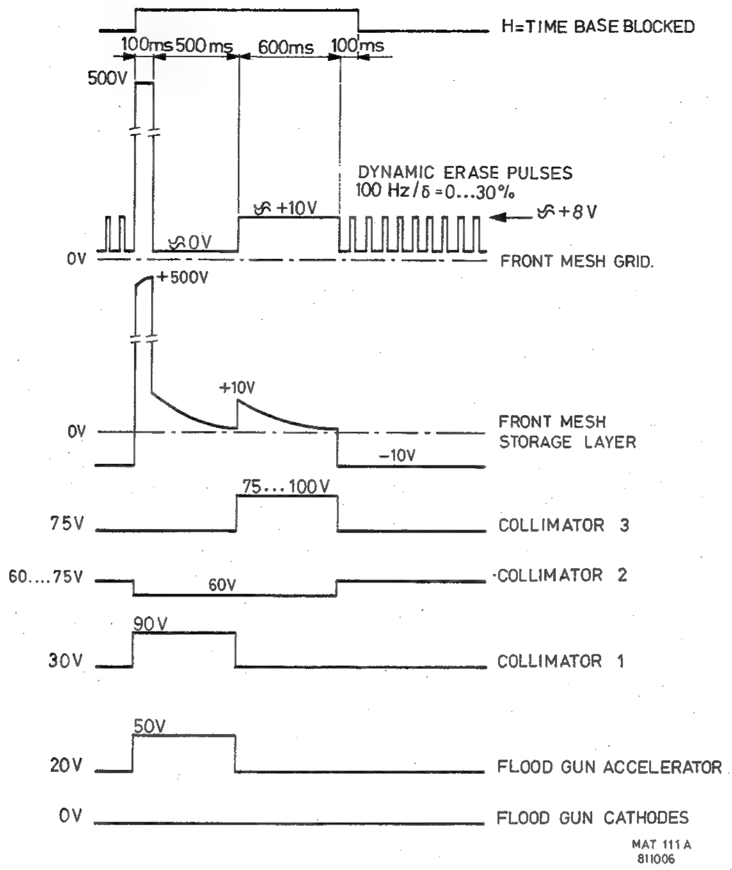


Fig.6.3. Voltage waveforms applied to the storage electrodes of the CRT in the WRITE mode.

6.1.5.3. *Fast mode*

In this mode, both storage meshes are used.
During the time base sweep information is written-in the fast mesh, which is t... flood-guns. As explained in section 6.1.5.1., the pattern in the fast mesh ca... Therefore, directly after the time base sweep, the pattern must be transfe... long storage time.
The transfer occurs as follows:
a 500V/100ms pulse is applied to the front mesh. At the same time the fast mesh is ... ...ial so that only written-in areas are above the cut-off level. The front mesh now attracts flood-gun electrons. However these electrons can only pass the fast mesh at the areas where it has been written-in. This means that the image is transferred to the front mesh where it is written-in by high energy (+500V) flood-gun electrons producing secondary emission.
Erasure of the front mesh: this occurs in similar fashion to that described in the write mode, using a first and a second erase pulse (See fig. 6.3.).
Erasure of the fast mesh: fig. 6.4. shows the potential behaviour for the fast mesh in the storage layer during erasure. The erase cycle can be compared with the erase cycle of the front mesh.
The +140V level that lasts from the end of the image transfer untill 900ms after the release of the erase knob can be regarded as the first erase pulse.
After this the potential is returned to +5V. The second erase pulse consists of the stabilisation or preparation pulses of +140V amplitude, 150Hz, and with a duty cycle of 0,07%
These pulses are able to maintain the charge pattern in the storage layer for some time.

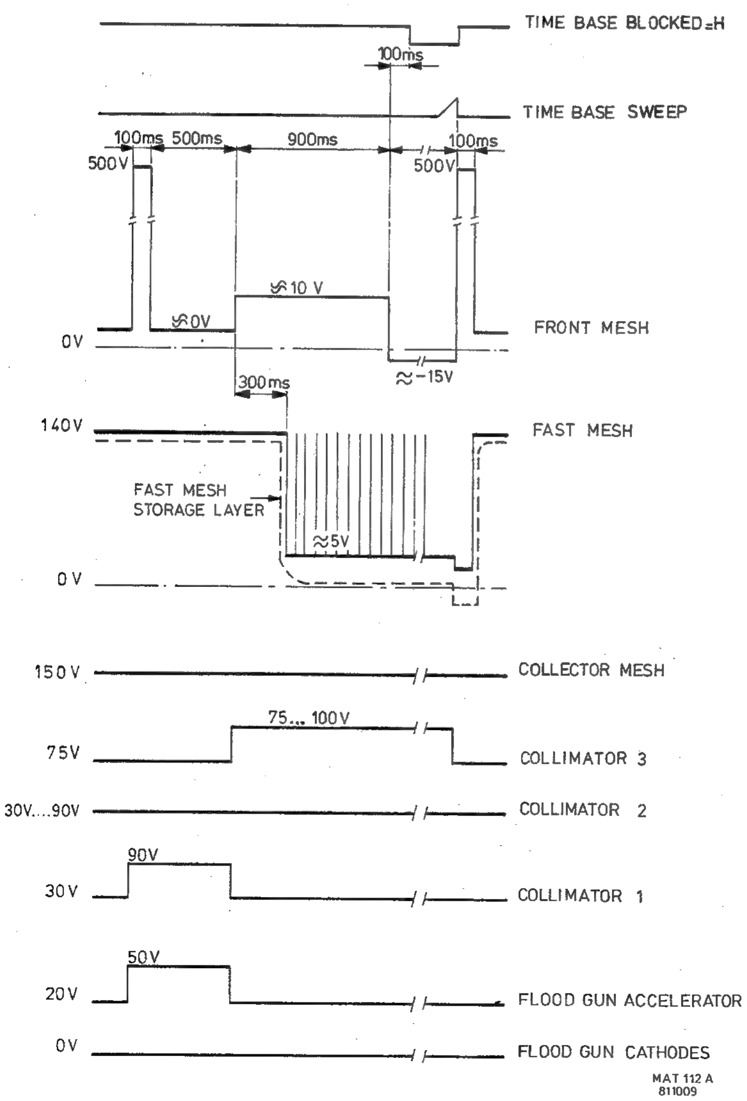


Fig. 6.4. Voltage wave forms applied to the storage electrodes of the CRT in the FAST mode.

During the whole erase/prepare - write - transfer cycle of the storage meshes the collimator electrodes 3, 2 and 1, and the flood gun accelerator are pulsed in the positive direction.

Figure 6.4. also shows a time-base blocking signal and the time-base sweep. The time-base is unblocked from 100ms after the end of the second erase pulse until the end of the time-base sweep; only during this period can it respond to a trigger signal.

6.1.5.4

...ctrodes of the c.r.t. are applied to constant d.c. voltages. Only the flood gun ... 100 Hz square wave with an upper level of +20 V and a lower level of 0 V. The ...een 0 and 80 % by means of the INTENS control (R14). A duty cycle of 80 % ...ss of the recorded waveform and 0 % gives a blanked display.

The remaining storage electrodes are applied to constant d.c. voltages, typically as follows:

- front mesh voltage between −5 V and +15 V,
- fast mesh voltage of +140 V,
- collector mesh voltage of +150 V,
- 3rd collimator voltage of +75 V,
- 2nd collimator voltage of between +30 V and +90 V,
- 1st collimator voltage of 30 V,
- the time-base is continuously blocked.

6.1.5.5. Non-store mode/memory off

In this mode the storage system of the c.r.t. is switched off and the storage electrodes are applied to constant d.c. voltages, typical values being as follows:

- front mesh at −35 V,
- fast mesh at +140 V,
- collector mesh at +150 V,
- 3rd collimator at +75 V,
- 2nd collimator at +30 V to +90 V,
- 1st collimator at +30 V,
- flood gun accelerator at +20 V.

6.1.5.6. *Storage section block diagram description*

The block diagram of the storage section is shown in Fig. 6.1. The voltage waveforms that are applied to the storage electrodes have already been described in the previous section. The storage electrodes are connected to the outputs of their appropriate amplifiers, i.e. the fast mesh is connected to the FAST MESH AMPLIFIER, and so on.

The FRONT MESH AMPLIFIER and the FRONT MESH PREAMPLIFIER are of special interest. If the output voltage of the FRONT MESH AMPLIFIER is "high", the front mesh is connected to +500 V; if the output voltage is "low", then the front mesh potential is that of the output voltage from the FRONT MESH PRE-AMPLIFIER.

The amplifiers receive their input signals from the STORAGE LOGIC. This block can be subdivided into the following functional sections:

- pushbutton switch detector
- timer
- auto-erase timer
- dual oscillator
- ETB and BTB pulse generator
- stabilisation pulse generator
- input switching for storage amplifiers

PUSHBUTTON SWITCH DECODER

This block is operated by the front-panel storage control pushbuttons: STORE, WRITE, and FAST (S24A, S24B and S24C). Depending on the combination of the pushbuttons selected, one of the four functional outputs FAST, WRITE, STORE and NON-STORE is activated. A faulty pushbutton combination automatically activates the STORE output. The decoder is arranged in such a way that a further selected pushbutton combination does not affect an erase/preparation - write - transfer cycle that is already in progress. Only at the end of the cycle can the new pushbutton combination become effective.

TIMER

In the WRITE and FAST modes this block generates output pulses for the timing of the erase/prepare cycles. If the ERASE pushbutton (S25) is released, or if the AUTO ERASE TIMER generates an output pulse, the TIMER generates pulses on separate outputs after 100 ms, 600 ms, 900 ms, 1200 ms and 1500 ms.

AUTO-ERASE TIMER

In the FAST mode this block generates pulses if the VIEW TIME control (R16) does not occupy the MAX position. These pulses trigger the TIMER in the same manner as after release of the ERASE pushbutton. The pulses have a duration of 1 ms and a repetition rate that is adjustable by means of the VIEW TIME control of between 3 s and 8 s. In other words, after a view time that is adjustable between 3s and 8 s the display is erased and another picture is written if the time-base is triggered.

DUAL OSCILLATOR

The dual oscillator receives a 100Hz triangular voltage from the 100Hz MASTER OSCILLATOR. This oscillator is not synchronised by the mains supply voltage. One output from the DUAL OSCILLATOR produces a 100 Hz square wave of which the duty cycle can be adjusted between 0 and 30 % by the PERSISTENCE control (R16). This signal is used to pulse the front mesh in the variable persistence position.
The other output produces a 100 Hz square wave of which the duty cycle can be adjusted between 0 and 80 % by the INTENS control (R14). This signal is used to pulse the flood gun accelerator in the STORE mode in order to adjust the brightness of the recorded waveform.

ETB PULSE AND BTB PULSE GENERATOR

This block generates in the FAST mode pulses at the end of the time-base sweep (ETB pulse) and at the beginning of the time-base sweep (BTB pulse).

At one output a positive-going pulse appears at the beginning of the sweep of the selected time-base, and at the other output a positive-going pulse appears at the end of the sweep of the selected time-base.

STABILISATION PULSE GENERATOR

This block operates in the FAST mode and generates "needle" pulses with a frequency of 150 Hz and a duty cycle of 0.07 %. These pulses are applied to the fast mesh of the c.r.t.

INPUT SWITCHING OF STORAGE AMPLIFIERS

This block produces the output signals that feed the inputs of the storage amplifiers. In turn, these amplifiers drive the storage electrodes of the c.r.t.

The output signals of the INPUT SWITCHING block are derived from the output signals, produced by the DUAL OSCILLATOR, the ETB/BTB PULSE GENERATOR and the STABILISATION PULSE GENERATOR.

The pulse sequence of the output signals is determined by the setting of the storage control pushbuttons (S24A, S24B, S24C)together with the output pulses from the TIMER. These output pulses from the TIMER are initiated on the release of the ERASE pushbutton or by the AUTO-ERASE TIMER.

6.1.5.7. *Focus and Z-Amplifier Block Diagram Description*

The focusing of the electron beam of the c.r.t. is controlled by the setting of the INTENSity control (R14). This coupling between the Z-amplifier and the focus is such that the spot on the c.r.t. screen remains well focused over almost the entire intensity range.

The c.r.t. has a scan magnifier facility and this necessitates two focussing electrodes; one is active in the vertical direction and the other is active in the horizontal direction.

The intensity is influenced by the following signals:

- The setting of the INTENS control (R14).
- A signal applied to the external Z-modulation input X8.
- A signal from the chopper oscillator, used for blanking in the CHOPped mode.
- A signal from the X-deflection selector, used for display blanking in the ALTernate mode.
- A signal from Unit 802 that limits the Z-pulse to 35Volt in the main time base positions 1S ... 5ms/DIV The signal originates from the main time base TIME/DIV switch.
- A signal from Unit 802 that limits the Z-pulse to 35Volt in the external X-deflection mode. The signal originates from the X-deflection selector.
- A signal from Unit 802 that allows a Z-pulse of 75Volt in the single shot mode. It originates from the AUTO/TRIG/SINGLE switch.
- A signal from Unit 802 that allows a Z-pulse of 75Volt in the fast mode. It originates from the sweep gating logic.
- A signal from Unit 802 that allows a Z-pulse of 75Volt in the magnifier X10 mode. It originates from the X-deflection selector.
- A signal from the storage logic that blanks the display if an erase cycle of the storage system is going on.
- A signal from the storage logic that blanks the display in the store mode.

The above-mentioned input signals are applied to the INTENSITY AND FOCUS PREAMPLIFIER. This amplifier has two outputs that have identical signals, but with a phase difference of 180 degrees.
One output feeds the Z-amplifier. The other output feeds the FOCUS AMPLIFIER

The output signal from the Z-amplifier must be applied to the Wehnelt cylinder (G1) of the c.r.t. which stands at a potential of about –3 kV. The h.f. components can be directly applied to G1 via a d.c. blocking capacitor. However, the d.c. and l.f. components are first applied to the MODULATOR where they modulate an h.f. carrier. They are then fed via a d.c. blocking capacitor to the DEMODULATOR. The output signal from the DEMODULATOR consists of the d.c. and l.f. components, which are then applied to the Wehnlet cylinder (G1) of the c.r.t.

The output signal from the FOCUS AMPLIFIER is divided into two parts; one for vertical focusing and the other for horizontal focusing.

The vertical focusing is controlled by R19, which adjusts the VERTICAL FOCUS AMPLIFIER that drives the vertical focusing electrode G5 of the c.r.t

The horizontal focusing is controlled by R17 on the front panel, which adjusts the HORIZONTAL FOCUS AMPLIFIER that drives the horizontal focusing electrode G3 of the c.r.t.
The deflection coefficients of the c.r.t. are affected by the cathode potential of the c.r.t. Therefore, the –3 kV cathode voltage is stabilised by a –3 kV STABILISER that has a potentiometer adjustment control.

6.1.6. Stabilized power supply

The mains voltage is full-wave rectified and fed to a regulated sine converter.
The output voltage of the sine converter is kept constant by regulating the duty cycle of the applied voltage.
This output voltage is applied to the primary of a transformer, the secundary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The MAINS triggering signal is taken direct from the mains and, via an opto-isolator, fed to the trigger circuitry on a safe level.
An additional power supply unit makes the supply voltages for parts of the storage system.

6.2. VERTICAL DEFLECTION SYSTEM

The oscilloscope contains three vertical channels, channels A and B and the TRIGger VIEW channel.
The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.
A channel switch, controlled by the display mode pushbuttons, switches either channel A or channel B or the TRIGger VIEW channel to the final Y amplifier via the delay line driver and the delay line. The final Y amplifier feeds the Y deflection plates of the cathode-ray tube.
The individual stages of the vertical deflection system are now described in some detail.
As the channel paths for channel A and channel B are basically identical, only the channel A signal path is described.

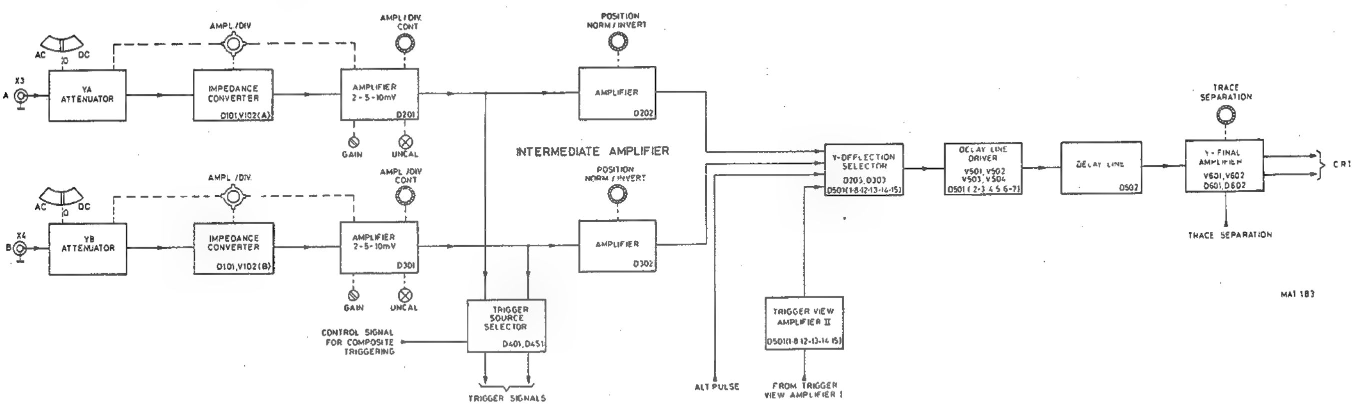


Fig. 6.5. Vertical deflection system

Input coupling

Input coupling switch S17 (AC-0-DC) forms a part of the input attenuator unit (Unit 2).
Input signals connected to the A input socket X3 can be a.c. coupled, d.c. coupled or internally disconnected.
In the AC position of S17, there is a capacitor (C102) in the signal path. This capacitor prevents the DC component of the input signal from being applied to the amplifier and reduces so the lower frequency limit to 7 Hz.
In position DC of switch S17, the input signal is coupled directly to the step attenuator and at the same time, blocking capacitor C102 is discharged via R101, to prevent damage of the circuit under test by a possible high charge.
Selection of the 0 position of S17 isolates the channel A input signal and earths the channel input for reference purposes; e.g. for calibration or centering the trace.

Input attenuator and impedance converter

The input stage comprises two identical attenuator circuits which are combined in one unit (unit 2).
For convenience, only the channel A attenuator is described.

The input attenuator consists of a triple high-ohmic voltage divider and an impedance converter in conjunction with a drift-correction circuit. The impedance converter provides an output at zero level, which can be adjusted by potentiometer R129, followed by a low-ohmic attenuator with attenuation factors of 1, 2 and 5.

The overall attenuation of the input stage is determined by the combination of the selected sections of two voltage dividers. The various combinations are selected by the eleven positions of the front panel AMPL/DIV attenuator switch S9.

The high-ohmic voltage divider sections attenuate by a factor of X1, X10 and X100. The low-ohmic divider D102 following the impedance converter, V102, V103, V104 gives attenuations of X1, X2 and X5 at the output. With the overall combinations of attenuation, eleven Y deflection coefficients are realised from 2 mV/DIV to 5 V/DIV in a 1-2-5 sequence. Only for the most sensitive positions 2 mV/DIV and 5 mV/DIV of the AMPL/DIV switch S9, the gain of the intermediate amplifier is increased.

Constant input capacitance for the various attenuator positions is achieved by trimmers C101, C104 and C109. The high-ohmic voltage divider sections are made independent of the input frequency (i.e., the capacitive attenuation for a.c. signals is adjusted to the resistive attenuation for d.c. signals) by means of trimmers C107 and C112.

A diode clipper V101, in the gate circuit of FET-transistor V102 protects the input source follower of the impedance converter from excessive voltage swings.

The high frequency path of the input signal consists of capacitor C114 and FET-transistor V102 connected in a source-follower configuration. The low frequency path of the input signal consists of error amplifier D101, which samples the input and output signals of the impedance converter over a frequency range from d.c. to 1 kHz. The error amplifier generates a correction signal on pin 6 which is fed to the impedance converter to replace the missing low frequency components of the high frequency path.
The gain of the low frequency path is set by adjusting the resistor divider ratio from which the output is sampled. Preset R 132 (L.F. corr) is adjusted so that the ratio of the network R134/R132 is the same as the ratio of network R122/R123. The off-set voltage of the error amplifier is corrected by preset R124.

After low-ohmic attenuator switching, the output from the impedance converter provides a correct impedance match for the coaxial cable to the intermediate amplifier.

Intermediate amplifier

The intermediate amplifier comprises two main stages.
The first stage comprises the gain adjustments, vernier and continuous control, level shifting, and sensitivity for the 2 mV, 5 mV and 10 mV ranges.

The second stage comprises a series-shunt feedback amplifier circuit formed by D202 input transistors and transistors V502, V504 on the delay-line driver circuit. Interposed in this stage are the normal/invert, shift and electronic switch facilities.

Both stages have overall gains of approximately 3.

To improve temperature control and stability, the intermediate amplifier mainly comprises integrated circuits. The signal paths for channel A and channel B are identical in the input stages, consequently, only the channel A input circuit is described.

The Y signal from the channel A attenuator is applied to a coaxial input socket on the intermediate amplifier, to pin 3 of integrated circuit D201. The asymmetrical input is converted to a symmetrical output in a transistor balance amplifier.

Potentiometer R211 provides a continuous balance control to correct for line shift.
Four diode-connected transistors across the base circuits of the D201 cascode transistors provide control of attenuation by means of GAIN control R12 and CONT. control R8, which vary the dynamic resistance of the diodes. Control R12 gives 5 % loss of gain in the mid-position and 10 % loss of gain at minimum. Control R8 gives a 3 to 1 attenuation, which is sufficient to give the desired overlap between the input attenuator steps. When the currents through the diode bridge are equal, there is no gain and the transistors are cut off. When current flows in one diode and not in the other, the gain is maximum.

The cascode transistors V204 and V203 that follow integrated circuit D201 provide additional gain for the most sensitive ranges by the selection of load resistors. By switching this additional gain at intermediate amplifier level a reduction in noise is achieved.
The different loads of V203, V204 are selected by switching diodes under the control of the front-panel AMPL switch positions.
In the 10 mV-5 V positions the - 5.2 V supply from AMPL/DIV switch S9 contact 14 is applied to the junction of R241, stabistor V208 and diode V211. The stabistor V208 conducts and applies the negative potential via switching diode V206 to load resistors R233 and R237 of V204 and V203 respectively. Diode V211 also conducts and blocks V213, thus causing transistor V214 to switch off and disconnect the load resistors R236 and R239.

In the 5mV position, the - 5.2 Vsupply from AMPL/DIV switch S9 contact 20 is applied to the junction of R242, and diodes V209, V212. Diode V212 conducts and applies the negative potential via switching diodes V207 to the load resistors R234 in series with R233 and R238 in series with R237 of V204 and V203 respectively. Diode V212 also conducts and blocks V213, thus causing transistor V214 to switch off and disconnect the remaining load resistors. To compensate for the reduction of bandwidth in the 5mV position because of the higher value of the load resistor, an additional capacitor, C202, is switched into the emitter circuit via R212 and diodes V201 and V202.

In the 2mV position, transistor V214 conducts because of the 0V applied to its base via R243 and V213. The resulting negative potential on its collector is applied to the total load resistors R237, R238, R239 and R234, R233, R236 of V204 and V203 respectively. In this position, switching diodes V206 and V207 are blocked. The 2 mV position is an extra facility, the bandwidth being degraded to 35 MHz.

To compensate for any shift of the trace that may occur when switching between the 5 mV and 10 mV positions, preset R216 is provided. It permits the emitter current of V203 to be adjusted, as required.

Emitter potentials for V203 and V204 are routed via feed resistors R218 and R219 respectively. The RC networks R219, C212 and R222, C214 provide damping. Series RC networks R214, C208 and R208, C206 on points 1 and 8 of the cascode circuit of D201 prevent any tendency for parasitic oscillation.
The second stage of the intermediate amplifier is a voltage-to-current amplifier that incorporates the trigger pick-off point, the NORMAL/INVERT switching facility, and the channel selection switching. The stage basically comprises two integrated circuits D202 and D203.
Emitter points 4 and 5 (D202) of the input transistors provide the trigger pick-off points that are routed to resistors R421 and R422 on the trigger circuit. A number of RC networks across the common emitter circuit provide for bandwidth compensation over the frequency range. Preset components are R253, R254 R255, R257 and R244.

The NORMAL/INVERT function is performed by a diode-gate switching circuit under the control of the PULL TO INVERT switch S4. In the NORMAL position, i.e. S4 is open, transistor V216 conducts because of the negative base potential applied via R271. Point 11 of D202 is therefore at 0V and this is applied to the bases of two transistors, which conduct and pass the signal through D202 without inversion (points 1-14, 8-12). The negative potential via R269 is passed to point 9 of D202 on the appropriate side of the diode gate network. This negative potential is applied to block the bases of the other pair of transistors in the signal path.

In the INVERT position, i.e. S4 is closed, V216 is cut off because of the 0V potential applied via R271. Point 11 of D202 now becomes negative via R268 and this switchess off the two transistors that were previously conducting. The signal path is now inverted through the integrated circuit (points 1-13, 8-15) by the 0V signal applied via S4, R267 to point 9 of D202.

Any trace shift due to inversion can be corrected by preset R259.
The output signals are fed to pins 1 and 8 of integrated circuit block D203, the emitters of the electronic switching transistors. Channel selection is by means of a network, controlled from the logic circuit.

Front-panel POSITION control R3 applies a variable potential to the base of one of the input transistors to provide a means of shifting the trace.

Trigger pick-off and trigger source selection

The symmetrical trigger inputs from the A channel intermediate amplifier (D202) are fed via resistors R421 and R422 to points 3 and 6 of D401.
The symmetrical trigger inputs from the B channel intermediate amplifier (D302) are fed via resistors R471 and R472 to points 3 and 6 of D451.
Diode switches are again employed for channel switching for triggering on channel A, channel B or for composite triggering.
The outputs are asymmetrical and are taken via coaxial sockets to the trigger amplifier of the Main and Delayed time-bases.
The operation of the two integrated circuits D401 and D451 is identical. Therefore, only the channel A circuit D401 is described.

Transistor V401 provides a constant current source for the trigger pick-off stage for channel A. The collector output (point 7) is resistor-coupled to the common emitters of the switching transistors to provide a high gain output on point 13 (MTB trigger output) and point 15 (DTB trigger output) when the appropriate triggering is selected. Switching is achieved by front-panel selection. When channel A (DTB) is selected, the +11,4 V from point 2 of S21-A (which blocks V403 in the channel A OFF position) is removed and V403 conducts the channel A trigger signal (D401/15) to the delayed time-base trigger amplifier. When channel A (MTB) is selected, the +11,4 V from point 1 of S22-A is removed and V404 conducts (V407 off) to pass the channel A trigger signal on D401, point 13) to the main time-base trigger amplifier.

In the composite triggering mode, which is only functional when also ALT mode is selected, point 4 of S22-A is open circuited, consequently, transistors V408 and V458 and also transistors V457 and V407 are now controlled by a signal coming from the vertical logic circuit via R1622 and R494 . This signal brings transistors V458 and V408 alternately into conduction to enable triggering on the channel being displayed.
Transistor V409 inverts the logic input signal to allow alternate switching of the two channels.
Diodes V454 and V404 are alternately conducting and the A and B trigger signals are alternately routed to the MTB trigger amplifier.
Presets R431 and R481 enable the switching points of the diodes V404 and V454 to be set.
Presets R478 and R428 compensate for any current differences between the A and B triggering signals to enable the same current to be delivered to the trigger amplifiers.

Vertical display mode logic

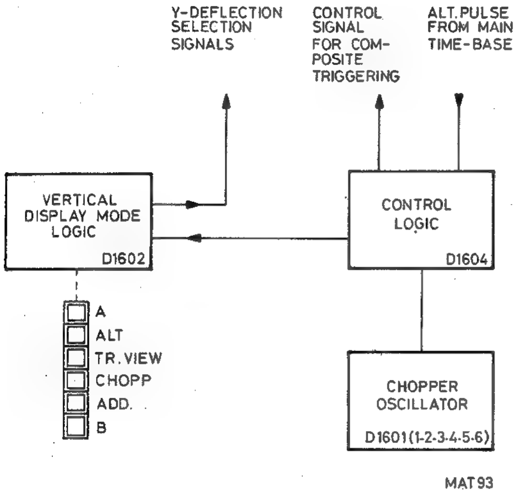


Fig. 6.6. Vertical display mode logic

This logic consists of digital circuits employing dual-in-line TTL integrated circuits. Vertical mode selection is made by selector switch S1.
The outputs that can be selected by the vertical display mode selector switch S1 are:
– channel A only
– channel B only
– TRIG VIEW signal only
– channels A and B added, chopped or alternated
– TRIG VIEW signal and channels A and B, chopped or alternated.

Positive logic is used in the digital circuits, the levels being as follows:
logic "1" = +5 V (high)
logic "0" = 0 V (low)

The different functions of the logic circuits are now described according to the vertical display mode selector switch S1.

A – selects channel A only. Via switch S1 the S input (point 7) of flip-flop D1604 is set to +5 V and the R input (point 8) to 0 V. The "high" level at output 10 is fed via two NOR circuits and R1628 to R283 in the A channel preamplifier to open the A channel signal path.
At the same time the control signals for the B and the TRIG VIEW channel are 0 V.

B – selects channel B only. Via switch S1 the S input (point 7) of flip-flop D1604 is set to 0 V and the R input (point 8) to +5 V. The high level at output 11 is fed via two NOR circuits and R1627 to R383 in the B channel B channel preamplifier to open the B channel signal path.
At the same time the control signals for the A and the TRIG VIEW channel are 0 V.

ADD – adds channels A and B. Inputs 2 and 5 of NOR circuits D1603 are connected to +5 V via switch S1, consequently both outputs 1 and 4 are low. They are fed via the NOR circuit and the resistors to R283 and R383 in the A and B channel preamplifiers to open both signal paths simultaneously. The TRIG VIEW control signal is 0 V then.

TRIG VIEW – selects the trigger signal only. Via switch S1 a +5 V is applied to points 4 and 5 of NAND D1607 (4-5-6). Output point 6 is fed via NOR D1602 (1-2-3) and resistors R1629 to R547 in the trigger view amplifier to open the trigger view signal path.
The channel A and B control signals are 0 V then.

CHOP – selects channels A and B chopped. In this position the chopper generator, which consists of NAND circuits D1601 (4-5-6) and D1601 (1-2-3), is switched into the circuit by a +5 V applied to input 4. The frequency of oscillation is 2 MHz. The output signal is fed via two NANDS to the clock input of flip-flop D1604. The only flip-flop of interest now is the first one. It divides the incoming frequency by two and switches at a frequency of 1MHz. The resulting high switching levels on the outputs 10 and 11 of the flip-flop provide the chopping signals for the A and B channels.
The control signal for the TRIG VIEW channel is blocked in this situation.

During switching over in the CHOP mode, the c.r.t. is blanked by pulses supplied via transistor V1601 to R2002 of the blanking stage.

ALT – selects channels A and B alternately for display. The circuit acts as in the CHOP mode, only the chopper generator is blocked and the circuit is driven now by the much slower switching signal applied to input 2 of NAND D1608 (1-2-3).
This switching signal is derived from the main time-base generator (V903) or the alternate time-base logic. These pulses switch the circuit at the end of each sweep and the channels A and B are alternately displayed.
In ALT TB mode the circuit is switched at the end of every two sweeps.
The control signal for the TRIG VIEW channel is 0 V.

ALT TRIG VIEW – selects channels A and B and TRIG VIEW alternately. So three signals can be made visible on the screen, but only one at a time is written.
For the generation of the control signals see Fig. 6.7. Clock pulses are here the alternate pulses.

TRIG VIEW CHOP – selects channels A and B and TRIG VIEW chopped. Three signals can be made visible on the screen, but now in chopped mode.
For the generation of the control signals see Fig. 6.7. Clock pulses are here the chopper generator output pulses.

Composite triggering

The output signal of point 10 of flip-flop D1604 is applied via R1622 to resistor R494 in the trigger source selector.

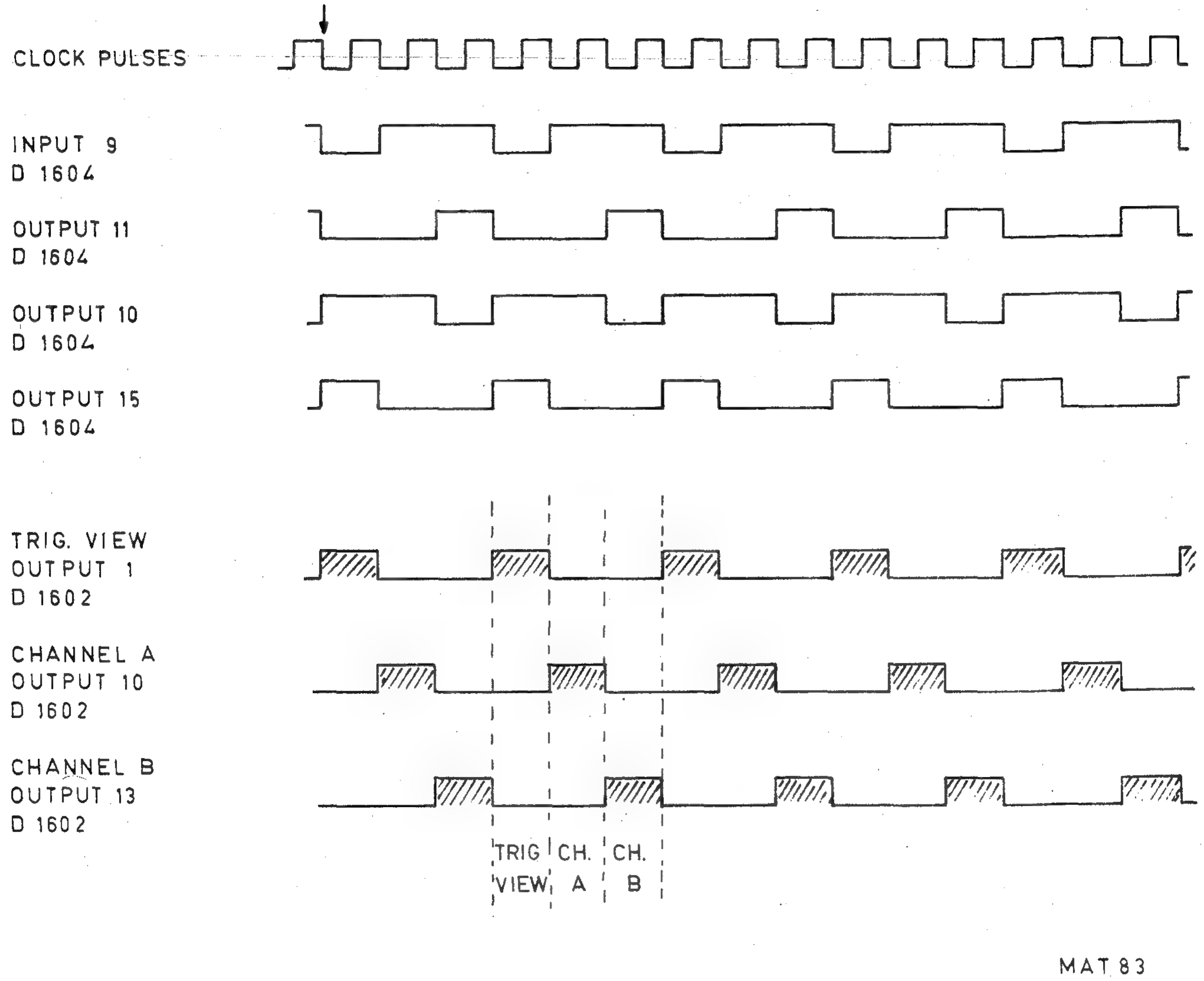


Fig. 6.7. Generation of control pulses in vertical display mode logic

Channel switching and delay-line driver

The signal collector outputs from channel A (D203/12,14) are coupled to the bases of the transistors of the shunt-series-feedback amplifier V502/V504. Each collector output normally draws, via resistors R279 and R282, 10mA from the current source V501/V503.
When the A channel is switched off the signal transistors in D203, connected with pin 12 and 14 are blocked and two times 10mA is interrupted. Now two compensation transistors in D203 connected with pin 13 and 15 are switched on so that they now draw together 20mA current from the +11.4V rail via R502, R501 and R507. As a result D203 always draws a current of 20mA. With the channel switched on the current flows via R279 and R282 to pin 14 and 12. With the channel switched off the current flows via R281 to pin 13 and 15 .

In a similar way as described above channel ~~B and the TRIG VIEW channel are switched and connected with~~ series feedback amplifier V502/V504 and current source V501/V503. Independent from the number of channels that is switched on at a time the currents from V501, V503, V502 and V504 stay constant.

The collector outputs of transistors V502 and V504 are direct-coupled to the bases of the output transistors of the delay-line stage (points 3 and 6 respectively of integrated circuit D501). The collector outputs on points 2 and 7 of D501 feed the combined output resistor R552, the value of which matches the characteristic input impedance of the delay-line.

A delay-line is used with a characteristic output impedance of 75 ohms. From the delay-line, the signals are routed to the vertical output amplifier stage, via input resistors R602 and R609, which terminate the delay line in 75 ohms. Transistors V601 and V602 in common-base configuration provide the first stage of the vertical output amplifier.

Final Y amplifier

The voltage signals present on R604 and R613 are applied to the bases of transistors (point 3 and point 6) of integrated circuit D601.
The emitters of these transistors (points 4 and 5) are fed from a constant-current source, V606, via transistors V607 and V603. The base of V607 is controlled via V608 from the TRACE SEP; potentiometer R6 on the time-base circuit.
This potentiometer varies the current on the side of the balanced amplifier to give trace separation in the ALTERNATE TB mode.
The networks R634, C613, R636, C614 and C616 provide delay-line correction at different frequencies.
High frequency compensation for this stage is achieved by V609, C617 and V611, C618 adjusted by preset R646. The NTC resistor temperature-controls the vari-cap capacitance and compensates for increase in temperature.
Integrated circuit D601 and thin-film circuit D602 form a shunt-series feedback circuit, followed by a cascode amplifier with voltage output developed across the load resistors inside D603.
The Y plates of the c.r.t. are fed via series chokes L601 and L602 damped by the parallel resistors R662 and R664.

Together with the capacitance of the c.r.t. plates, this forms a series resonant circuit to lift the gain at the high frequency end of the bandwidth. Preset R654 provides a measure of gain adjustment (20 % approx.) to allow for different c.r.t. sensitivities.
It controls the quiescent current of the diodes and thus the gain of the D601 amplifier stage.
Any unbalance in the c.r.t. deflection plates can be corrected for by the line centring preset R658, which provides a compensating current for one side of the balanced output stage.

6.3. MAIN TIME-BASE TRIGGERING

The trigger source switches for triggering the main time-base generator, can select any of the following input sources.:
- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal composite signal of channel A and channel B
- a signal derived from the mains supply
- an external source.

All these sources can be used for both triggering and X Deflection purposes. Source selection is done by means of a trigger selector switch S22.

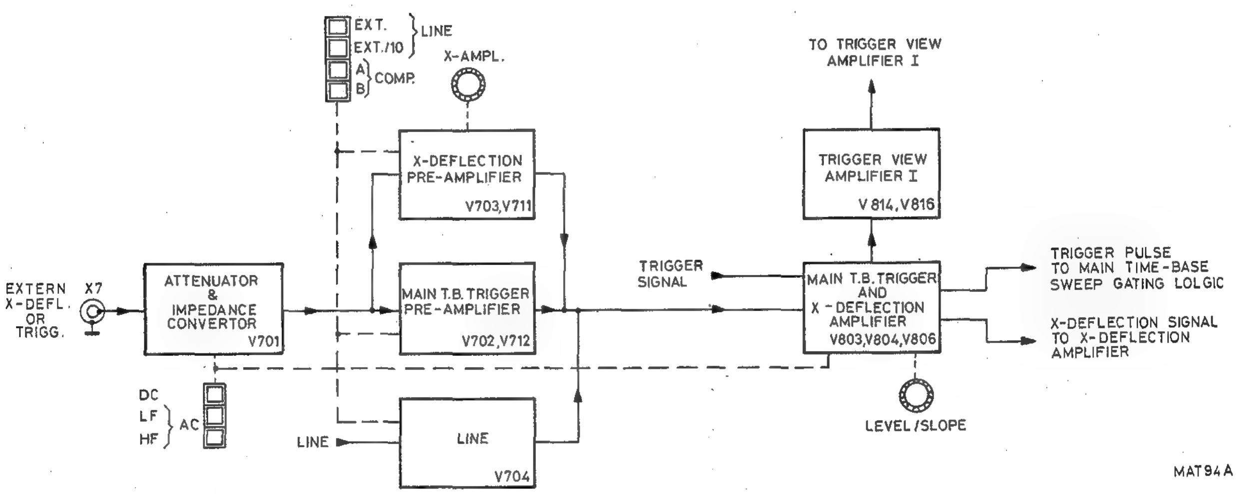


Fig. 6.8. Main time-base trigger circuit

Main time-base trigger source selector and preamplifier

The signal which is applied to the external trigger or X-deflection input X7 is attenuated via R702 and R703 by a factor of 10 in the EXT ÷ 10 mode.
When DC coupling is selected with switch S20, a DC path is formed via the resistors R707 and R708 to input 3 of D701. In the LF and HF mode the DC path is blocked. The l.f. component of the signal is fed via capacitor C704 to point 3 of D701 and the h.f. component is then fed via capacitor C703 to FET V701. The output signal from V701 and D701 is then applied to the bases of the transistors V712 and V711.
In the modes A, B, COMP and LINE the junction of R714 and R718 is connected to ⊥ via switch S2, transistors V702 and V703 are conducting thus blocking the signal paths via the diodes V708 and V709.

In LINE mode R722 is not longer connected to ⊥ and transistor V704 is blocked. Diode V707 will conduct and the signal path for the LINE signal is opened.

When modes EXT or EXT ÷ 10 are selected there is no voltage applied via S22 to the junction of R714 and R718. In these modes there is only one of the transistors V702 and V703 conductive and the other one is then blocked.

If V702 is conductive, the signal path via diode V709 will be blocked. The signal path via diode V708 will be blocked when V703 is conductive.
If V702 or V703 conducts depends on the setting of switch S2.
There is no voltage applied via S2 to R716 and R717 in normal horizontal deflection by MTB and/or DTB signals. Transistor V702 is blocked, V706 and V703 conduct and the signal path via diode V709 is opened.
In EXT-X DEFL mode a +5 V signal is applied to R716 and R717 and V702 is conducting. At the same time V706 and V704 are blocked and the signal path via diode V708 is opened. The X-AMPL potentiometer R18 in the emitter circuit of V711 is now brought into the circuitry.

Main time-base trigger amplifier

The main time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier. In this trigger amplifier, there is an output taken off for trigger view.

The signal current from the intermediate amplifier (channel A, channel B, or composite) is fed via the trigger source selector circuit to the emitter of V803. The output from the trigger source (EXT, EXT ÷ 10, or LINE i.e. mains frequency) is also fed to the emitter of V803.
This transistor, connected in common-base configuration, is coupled to the shunt feedback stage V804, V806.
The output of this stage is diode-coupled to the filters for the various coupling modes.
By means of these filters, the input frequency range of the trigger circuit can be set.
The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example the DC position, selected by switch S20, is switched in by the −11,4V which causes diodes V809 and V812 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V813, which compensates for the temperature drift of transistor V804.

On the trigger amplifier, the trigger view signal and the trigger signal proper are split up by means of two amplifier stages.
The two transistors V816 and V817 accept the trigger signal. The transistors V814 and V818 accept the trigger level voltage. The LEVEL voltage control R7 permits variation of the trigger level of the signal.
The trigger view gain can be varied by means of preset potentiometer R842 in the emitter circuit of transistors V814 and V816.
The collectors of transistors V814 and V816 provide the trigger view output and the collector currents of transistors V817 and V818 are fed to the shunt feedback stage V821 and V822 respectively, thus providing the trigger signal.
In the negative position of the +/− SLOPE switch S7, the trigger signal is taken from one of the collectors via transistors V824 and V827 and in the positive position via transistor V823 and V826. +/− SLOPE switch S7 determines the polarity of the trigger signal. In the closed positon a 0V signal cause, V827 to conduct the negative trigger, and also switches off V829. In the open positon, V829 is switched on and the positive trigger is routed via V826 and V827 is blocked.
In this way, the appropriate trigger signal appear at the combined emitters of transistors V826 and V827.
This trigger signal is routed via a Schmitt-trigger formed by D802 (2-4-5), R894 and R895 to the flip-flop D901 in the main time-base sweep gating logic.

6.4. MAIN TIME-BASE GENERATOR

The main time-base generator comprises a sweep gating logic, a sweep generator, a hold-off circuit and an auto sweep circuit.

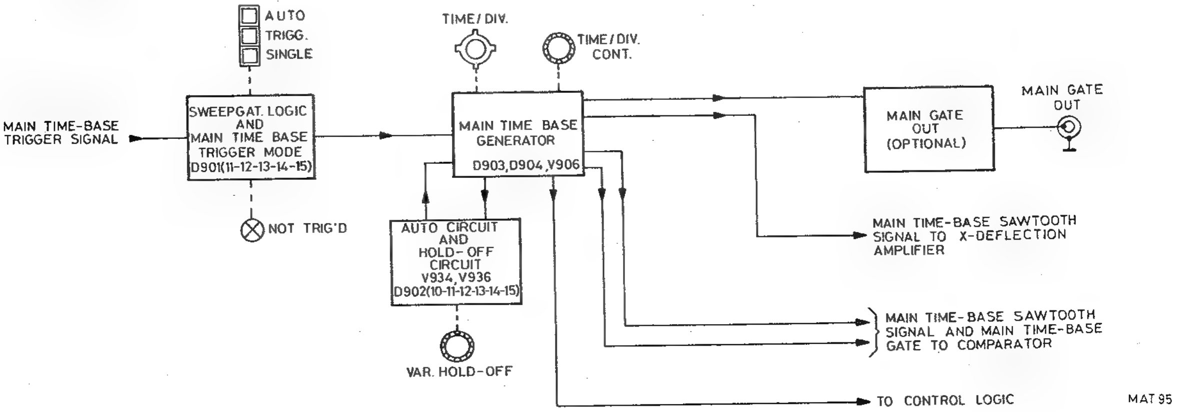


Fig. 6.9. Main time-base generator

The operation of the main time-base generator is based on the principle that a capacitor charges linearly when a constant-current source is applied, and can be periodically discharged rapidly by means of an electronic switch. In this way, a linear saw-tooth waveform is generated.

The constant-current source consists of transistors V913, V914 and integrated circuit D903. The emitter voltage of V914 has the same potential as point 3 of D903, therefore a constant voltage exists across the series circuit of R926 and the charging resistors on switch TIME/DIV S15. This voltage, and thus the charging current may be varied by means of potentiometer R11 and the preset potentiometers R911 and R913, which compensate for the tolerances of the timing capacitors.

In the TRIG. position V931 is switched off because of the +5,2 V applied to its base by switch S8 (AUTO). If point 14 of the master slave flip-flop D901 is logic "high" due to a trigger pulse, V929 will also be switched off.
Consequently, its collector will be negative and switching transistors V906, V907 will be turned off (discharge switch open) and the timing capacitors C916 and C917 in parallel (and C912, C913 or C914 as selected) will be charged. This charging voltage is applied via the buffer stage consisting of the Darlington pair emitter-follower V922, V923 (h.f. path) and via the operational amplifier D904 together with V924 (l.f. path) to point 12 of the R; S; flip-flop D902. This flip-flop reaches its switching voltage when the time-base-saw-tooth voltage rises to approximately +4,3 V. Output 14 will then be "high" and output 15 will be "low". Since the collector of V937 is positive (see operation of AUTO circuit), diodes V927 and V926 will conduct and the "high" output on point 14 of D902 will be applied to point 12 (S input) of flip-flop D901. This results in a "low" output on point 14 of D901 irrespective of the state of the other inputs. The "low" output causes V929 to start conducting and its collector becomes less negative. Consequently, switching transistors V906, V907 conduct (discharge switches closed), the timing capacitance is discharged and point 12 of D902 drops below the switching level. Transistor V944, the base of which was turned off by the "high" output (point 14) of D902, is now switched off.
In turn, transistor V956 (discharge switch for the hold-off circuit) is switched off and allows the hold-off capacitance (C928 and C926, C927 as selected) to be charged by current source V954, D906. The voltage on point 3 of D906 is derived from a resistor that carries the charging current of the time-base generator. Therefore, the charging current for the hold-off capacitance is proportional to that for the time-base capacitance, thus giving a constant relationship between time-base length and the hold-off time. Potentiometer R18 (HOLD-OFF) allows the length of the hold-off period to be increased by a factor of 10. When the voltage across the hold-off capacitance has risen to a value of approximately 4,3 V the flip-flop D902 will be switched to its original state (outputs 14 low, 15 high), via buffer stage V949, V948. The "low" state on the base of V944 causes it to conduct and turn on V956 to discharge the hold-off capacitance. As a result, point 10 of D902 drops below its switching level. The S input of D901 will also be low again, whereupon the clock input (point 11) will be effective. The D input (point 10) is coupled with the clock pulse. Due to this pulse the flip-flop is switched over, resulting in a low level on point 15 and a high level on point 14 to permit the new time-base sweep.

Free run AUTO-circuit

If as a result of a trigger pulse, the Q output (point 15 of D901) is low, V934 and V936 start conducting and provide a discharge path for capacitor C923. Resistor R957 has been selected so that the current through R958 is insufficient to bring the base-emitter voltage of V936 to 0,7 V; therefore, both transistors are cut off as soon as C923 has discharged, provided that the Q output has switched to "high" in the meantime. The voltage on the negative side of C923 is then approximately +3,5 V and V937 is turned off, as a result of which diodes V926 and V927 are able to transfer the pulse on D902 output 14 to input 12 of D901.
Transistor V931 is turned off because its base is held at +5,2 V via R959, R960 and R962 (switch S8 (AUTO) is interrupted in the AUTO position). Thus, with a trigger signal input the time-base operates in the same way as in the TRIG position.

However, in the absence of a trigger signal, when D901 output 15 is "high", capacitor C923 will be slowly charged to approximately –6 V. If before this charging time (0.1 s approx.), point 15 turns to "low" (due to a trigger signal), C923 is discharged again before V937 starts conducting. As a result, V937 remains switched off and the instrument is still triggered.

If the voltage across C923 is permitted to charge to –6 V (i.e. no trigger signals appear), V937 starts to conduct and the resulting negative on its collector blocks diodes V926 and V927. At the same time, the base voltage of V931 drops. Consequently, the pulse on output 14 of D902 is no longer transferred to input 12 of D901, but is fed direct to the switching transistors V906, V907 via diode V932 and transistors V931 and V929.

In this way, the time-base generator runs automatically without the intervention of a trigger pulse. Transistor V937 is conductive when the time-base generator is not triggered. The base of V939 is then low, as a result of which the transistor conducts and the NOT TRIG'D lamp (V2) lights.

3.2.3.2. SINGLE SHOT mode

In the trigger position SINGLE, the time-base hold-off capacitors are short-circuited by diode V953 and switch contacts S8 (AUTO) and S8 (TRIGG). In the FAST mode the hold-off capacitors are short-circuited via V953 and V958.
The flip-flop D902 must then be reset manually by the RESET button S8 (SINGLE), which applies +5,2 V via R975, V946 to input 10. After input 10 has been brought to a high level and the RESET button released, triggering can occur, but on one event only as the flip-flop is not reset automatically.
In the SINGLE mode, V937 is permanently turned off via R965 by S8 (AUTO) and S8 (SINGLE). Since diodes V941 and V942 are now conductive, the pulse on output 14 of D902 will be transferred to the base of V939.
Consequently, the NOT TRIG'D lamp will light during the period when output 14 of D902 is low, i.e. from the moment the RESET button is pressed until the end of the time-base sweep initiated by the incoming trigger pulse of the event under observation.

6.5. DELAYED TIME-BASE TRIGGERING

The trigger source switches for triggering the delayed time-base generator, can select any of the following input sources.

- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal signal derived from the main time-base to start the delayed time-base immediately after the selected delay time
- an external source

Source selection is done by means of a trigger selector switch S21.

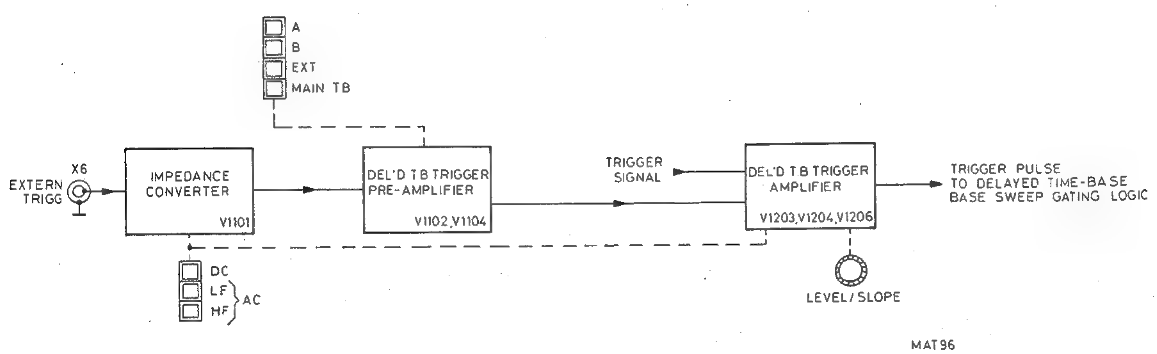


Fig. 6.10. Delayed time-base trigger circuit

Delayed time-base trigger source selector and preamplifier

The signal which is applied to the external trigger input X6 is fed via the input stage consisting of FET transistor V1101 and integrated circuit D1101 to the base of V1104.
When DC coupling is selected with switch S19, a DC path is formed via the resistors R1103 and R1104 to input 3 of D1101. In the LF and HF mode the DC path is blocked. The l.f. component of the signal is fed via capacitor C1102 to point 3 of D1101 and the h.f. component is then fed via capacitor C1101 to FET transistor V1101. The output signal from V1101 and D1101 is then applied to the base of transistor V1104.

In the modes A, B and MTB the emitter of transistor V1102 is connected to the +11,4 V via switch S21, transistor V1102 is conducting thus blocking the signal path via the diode V1103.
When mode EXT is selected, there is no voltage applied via S21 to the emitter of transistor V1102. This transistor is blocked and the signal path via diode V1103 is opened.

The gain of the low frequency path is set by adjusting the resistor divider ratio from which the output is sampled. Adjusting is done with preset potentiometer R1118 (L.F. corr.).

Delayed time-base trigger amplifier

The delayed time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier.

The signal current from the intermediate amplifier (channel A, channel B or composite) is fed via the trigger source selector circuit to the emitter of V1203. The output from the trigger source (EXT) is also fed to the emitter of V1203.
This transistor connected in common-base configuration, is coupled to the shunt feed-back stage V1204, V1206.
The output of this stage is diode-coupled to the filters for the various coupling modes.
By means of these filters, the input frequency range of the trigger circuit can be set.
The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example, the DC position, selected by switch S19, is switched in by the –11,4V which causes diodes V1208 and V1209 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V1212, which compensates for the temperature drift of transistor V1204.

The two transistors V1213 and V1214 accept the trigger signal and the trigger LEVEL voltage respectively.
The LEVEL voltage control R5 permits variation of the trigger level of the signal.
The collector currents of V1213 and V1214 are fed to the shunt feedback stage V1217 and V1218 respectively, thus providing the trigger signal.

In the negative position of the +/– SLOPE switch S6, the trigger signal is taken from one of the collectors via V1222 and diode V1223, and in the positive position via V1219 and diode V1221.

+/– SLOPE switch S6 determines the polarity of the trigger signal. In the closed position a 0V signal causes V1223 to conduct the negative trigger and also switches off V1227. In the open position, V1227 is switched on and the positive trigger is routed via V1221 and V1223 is blocked.
In this way the appropriate trigger signal is supplied to the time-base.

6.6. DELAYED TIME-BASE GENERATOR

The delayed time-base generator comprises a sweep gating logic, a sweep generator, a comparator and an end of the sweep detector.

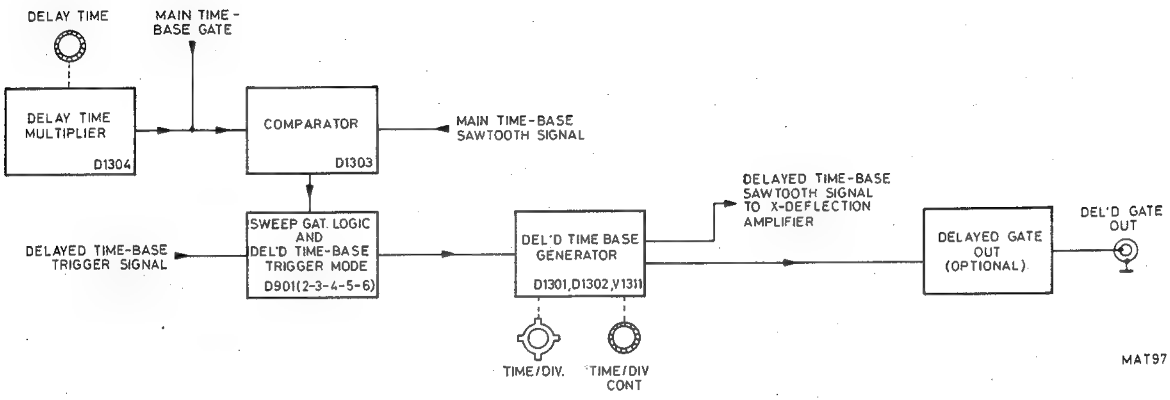


Fig. 6.11. Delayed time-base generator

Before considering these stages in detail, the general principle is briefly described.
Basically, the sweep gating logic, under the control of trigger signals from the trigger circuit and also feedback pulses from the end-of-the-sweep detector circuit, supplies square-wave pulses to the switching transistors V1309 and V1311 of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed via the X-deflection selector to the X-final amplifier.

Delayed time-base sweep generator

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.
The time-base capacitors C1311, C1312 are always in circuit, the capacitors C1307, C1308 and C1309 are selected by the transistors V1319, V1322 and V1323 respectively. These transistors operate as electronic switches and are either fully cut-off or fully-conducting. They are switched on by the application of a positive voltage on their bases from the TIME/DIV switch S13. According to the position of S13 the transistors switches in one of the capacitors in parallel with C1311 and C1312.
As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistors V1317 and V1318. This current can be adjusted in steps by selecting the emitter resistance of V1318 by means of the TIME/DIV switch S13.

Continuous control of the charging current can be effected by varying the drive to point 3 of integrated circuit D 1301 with the continuous sweep control, TIME/DIV potentiometer R10.
Potentiometer R1326 enables the sweep speeds of the delayed time-base generator to be equalized to those of the main time-base generator.
Together with C1307 and C1309, transistors V1314 and V1312 are switched into the circuit by a +5,2 V voltage from the TIME/DIV switch S13. In these positions potentiometers R1323 and R1322 provides a fine adjustment for the timing circuit.
The discharge circuit for the time-base capacitors consists of transistor V1311, which is driven by the sweep gating logic.
The resulting sawtooth voltage is fed via an l.f. path and an h.f. path to the X-deflection selector. The l.f. path consists of integrated circuit D1302 and transistor V1328 and the h.f. path consists of transistors V1326 and V1327.

Delayed time-base end of the sweep detection circuit

This circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output is applied to point 7 of SR flip-flop D902.

At the end of the time-base sweep, output 2 of the SR flip-flop D902 will be "high" and output 3 will be "low". These logic levels are transferred to pins 5 and 4 respectively of D901 irrespective of the state of the comparator D1303. As a result, the $\overline{Q}$ output becomes "low" and the timing capacitors are discharged via V1311, since the flip-flop D902 is not reset until the end of the main time-base sweep (D902-15 on MTB connected via a differential network to D902-5 on DTB). This situation will persist until the next sweep of the main time-base. If the main time-base sweep is completed before the end of the delayed time-base, the R and S inputs (5 and 4) of D901 are switched over and the delayed time-base capacitors also are discharged.
The system can now be triggered again.

Delay time function

The function of the DELAY TIME potentiometer R1 is to provide an adjustable d.c. voltage for comparison with the sweep voltage of the main time-base generator. This comparison is then used to start the delayed time-base generator at a pre-determined time during the sweep of the main time-base.
The DELAY-TIME potentiometer R1 is a 10-turn front-panel control.

Comparator circuit and sweep gating logic

The comparator consist of an integrated circuit D1303. Transistor (points 6-7-8) is a constant-current source for the transistors (points 1-2-3 and points 3-4-5) of a differential amplifier.
The d.c. voltage set by the DELAY TIME potentiometer R4 is fed to the base of transistor (points 3-4-5). The sawtooth voltage of the main time-base generator is fed to the base of the other transistor. As soon as the amplitude of the sawtooth exceeds the set d.c. voltage, a high level is passed from D1303, pin 5, to input 4 of master-slave flip-flop D901 (R input), and a low level from D1303, pin 1 to S input 5 of D901.
The $\overline{Q}$ output on point 3 will then be high, with as result that V1304 and the time-base capacitor discharge switches V1309 and V1311 will be turned off. This is the situation in the MTB position of the switch S21.
In positions A, B or EXT of delayed time-base trigger selection switch S21, point 4 of D901 is always low via S21 The delayed time-base then starts first upon receipt of trigger pulses on clock input 6, after the S input has dropped to the low level.

6.7. X DEFLECTION SELECTOR AND ALTERNATE TIME-BASE LOGIC

Depending on the selected position of X deflection source selector switch S2, the circuit provides for X deflection by the main time-base signal, the delayed time-base signal, a signal from an external source or X deflection by one of the internal signals derived from channel A, channel B or the mains voltage. There is also the possibility to select, the main and delayed time-base alternately.

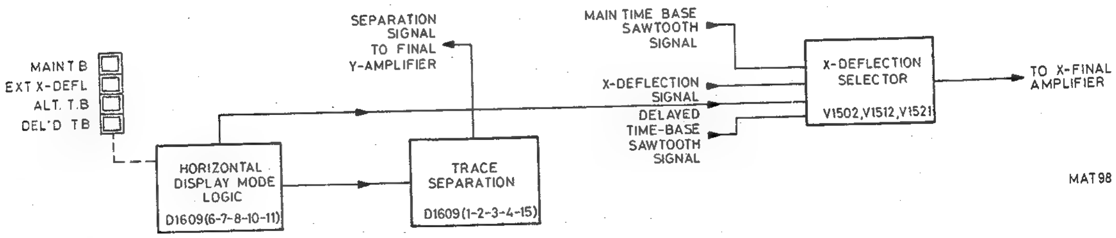


Fig. 6.12. X deflection selector and alternate time-base logic

The different functions of the logic circuits are now described according to the horizontal display mode selector switch S2:

MTB

– When no pushbutton is depressed or when MTB is depressed flip-flop D1609 is set in the MTB position via its R and S inputs (output 10 is high).
The MTB pushbutton releases all the other push-buttons of the horizontal deflection mode selector, its contacts are not used.
In the MTB position of switch S2, transistor V1509, which is driven by output 10 of flip-flop D1609, and consequently transistor V1511, conduct. Diode gate V1513, V1514 is therefore opened and the main time-base output is applied via transistor V1512 to the X amplifier, via these diodes and R1703.
In this mode only the main time-base sawtooth signal is fed to the X final amplifier and not the delayed time-base sawtooth signal and the X-deflection signal.

DTB

– With DTB selected flip-flop D1609 is set to the DTB state via its S and R inputs (output 11 is high).
In the DTB position of switch S2, transistor V1501, driven by output 11 of flip-flop D1609 and consequently transistor V1506 are conducting. The diodes V1503 and V1504 conduct and provide a signal path for the output sawtooth signal of the delayed time-base generator to the X final amplifier. With DTB selected the main time-base signal and the X deflection signal are blocked.

EXT X DEFL

– In the EXT X DEFL position a +5,2 V is applied via switch S2 to the base of V1516, with a result that the base of V1517 exceeds +5,2 V and this transistor is turned on.
Transistor V1524 then starts to conduct via R1528 and diode V1523 (8,2 V), and the external signal for amplifier V1519, V1521 is routed via the diode gate V1522, V1526 to the X amplifier.

When EXT X DEFL is switched off, transistor V1516 is turned off and transistor V1517 conducts via R1522. The collector of V1517 is therefore at +5,2 V, and as the voltage across diode V1523 is less than 8,2 V, this diode is blocked and transistor V1524 is turned off. In this position the X MAGN reed relay K1701 for the X1, X10, may be switched in. This is not operative when EXT X DEFL is switched on.

ALT TB

– With ALT TB depressed, the oscilloscope is set in the alternate time-base mode and the main and delayed time-bases are selected alternately.
ALT TB is not possible with DTB TIME/DIV switch S13 in the "OFF" position and with push-button TRIG VIEW of switch S1 depressed.
Switching over from MTB to DTB in ALT TB mode is achieved by switching in transistor V1509 and V1501 in turn via flip-flop D1609.
In ALT TB a +5 V signal is fed to input 4 of NAND D1606. With the delayed time-base switched off and with TRIG VIEW not depressed a 0 V signal appears at output 6 of NAND D1606. With this 0 V signal NAND D1608 (11-12-13) is blocked and flip-flop D1609 is set for normal switching by its clockpulse input signal. There is no longer a signal path for the alternate signal from the time-base generator to the vertical display logic other than via flip-flop D1609, NAND 1608 (8-9-10) and NAND D1607 (8-9-10).
The flip-flop output signal is also applied to R632 in the trace separation circuit to control the vertical space between the two time-base displays.

6.8. FINAL X AMPLIFIER

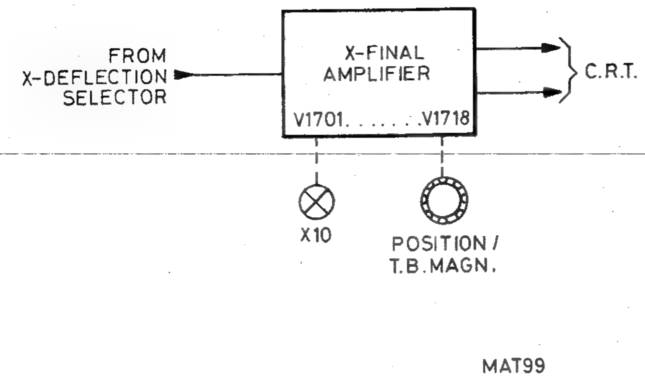


Fig. 6.13. Final X amplifier

The final X amplifier consists of two identical amplifier stages in parallel (one for each deflection plate). One stage consists of transistors V1706, V1707, V1708, V1709, V1722 and V1724 and the other consists of transistors V1714, V1716, V1717, V1718, V1726 and V1723.

The final stage is supplied from the +130 V and −130 V because the X plates of the C.R.T. are mechanically displaced such that they are less sensitive than the Y plates.

The amplifier stages are controlled via the transistors V1701 and V1702.

With the X POSITION potentiometer R2 and V1704 the bias of transistor V1702 can be varied. Potentiometer R2 consists of a tandem potentiometer R2a/R2b with back-lash, giving a nice vernier control. Variation of the bias causes the balance of the amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The X amplifier allows choice from X deflection by the time-base signals or one of the sources, channel A, channel B, line or an external signal. The X deflection source is selected with the aid of X deflection mode selector switch S2 and the X deflection source selector switch S22.
The selected X deflection signal is applied via R1703 to the base of transistor V1701.

The X amplifier offers the possibility of using either the nominal gain (X1 position of X MAGN switch S3), or the gain increased by a factor of 10 (X10 position of the X MAGN switch S3).
When the front-panel X MAGN switch S3 is operated for X10 magnification, the emitter resistance of V1701 and V1702 is shunted by resistors R1704, R1706 and R1707 via relay K1701, reducing the value by a factor of 10. Consequently, the gain of the stage is increased by the same factor.

The X1 gain can be set by potentiometer R1709 and the gain X10 by potentiometer R1706. The gain X10 is not operative when EXT X DEFL is selected.

Both outputs of the X final amplifier are connected to the X deflection plates of the C.R.T.

6.9. STORAGE SECTION

Introduction

See Fig. 12.19 for the circuit diagram. For information concerning storage principles read section 6.1.5.

The first part of this description deals with the functioning of the separate blocks mentioned in the block diagram description and explains the operation of each circuit block under various conditions and modes.

The second part of this description explains how the various pulses are generated that control the c.r.t. storage electrodes in the WRITE, FAST, STORE and NON STORE modes. The pulses generated in these modes are traced through the circuit blocks that are described in the first part to show how the various waveforms on the c.r.t. storage electrodes are derived.

The storage section of the oscilloscope comprises the following circuit blocks:

- Pushbutton switch decoder
- Timer
- Auto-erase timer
- Dual oscillator
- ETB and BTB pulse generator
- Stabilisation pulse generator
- Miscellaneous logic elements
- Quad bilateral switches D2401, D2402, D2403
- Storage amplifiers.

The logic circuits are of the LOCMOS type, which is sensitive to static discharges. An explanation is considered necessary for personnel who have had no handling experience with these devices.

HANDLING LOCMOS DEVICES

The word LOCMOS is the abbreviation for Local Oxidation Complementary Metal Oxide Semiconductor, which indicates that field-effect transistors with an insulated gate are used in this type of logic.
Although these field-effect transistors have input protection diodes, this type of logic is sensitive to electrostatic charges.
To safeguard against any possible damage to the LOCMOS circuits, the following rules must be observed:

a. Store and transport the circuits in their original packing, which short-circuits the leads or insulates them from external influences.

b. Electrically connect together to the same potential: testing or handling personnel, measuring equipment, soldering iron and circuit board with the LOCMOS circuits being handled. This potential can, of course, be earth.

c. After the LOCMOS circuits have been mounted on the board, proper handling precautions should still be observed. Until the subassemblies are inserted into a complete system in which the proper voltages are applied, the board is no more than an extension of the leads of the device mounted on the board. To prevent any static discharges from being transmitted through the board wiring to the device, it is recommended that conductive clips or conductive tape be put in the circuit-board terminals.

d. To prevent permanent damage due to transient voltages, do not insert or remove LOCMOS devices, or printed-circuit boards containing LOCMOS devices, from test sockets or systems with power on.

e. Handling personnel should be dressed in clothing of non-electrostatic material (i.e. no wool, silk or synthetic fibres).

Functioning of the storage system.

PUSHBUTTON SWITCH DECODER

The pushbutton switch decoder circuit decodes the position of the pushbuttons FAST, WRITE and STORE (S24C, S24B, S24A respectively).
If the WRITE and STORE pushbuttons are depressed together the MEMORY OFF (NON-STORE) function is selected.
If a faulty pushbutton combination is chosen then the STORE mode is automatically selected.

The decoder has eight logic output conditions: FAST, WRITE, STORE and NON-STORE (MEMORY OFF), which are high if the corresponding function is selected, and the four inverse states of these outputs. These logic outputs are available from the quadruple flip-flop D2204.

If the instrument is busy with a particular cycle, e.g. the erase cycle, then a new pushbutton combination cannot interrupt this cycle. This provision is achieved by the fact that the D flip-flop D2204 only loads the new pushbutton combination if it receives a clock pulse on input pin 9. This clock pulse (7 Hz) is derived from an oscillator formed by D2203/8, 9, 10 and D2203/12, 13, 11.
The oscillator is switched on if pin 9 of D2203 is at logic 1. A logic 1 is produced from the $\overline{\text{BUSY}}$ signal (busy not) in the fast and write mode if the instrument is not busy executing an erase, prepare or transfer cycle. Via diode V2221, and via R2203 and V2219 if the MEMORY OFF function is selected (diodes V2217, V2218 non-conducting by logic 1's on D2202 outputs 12 and 15).

PUSHBUTTON SWITCH DECODER

TRUTH TABLE

MODE	D2202-2	D2202-15	D2202-12	D2202-4	D2202-6	D2202-10	D2204 I/P				D2204 OUTPUT MODE PULSES				NAND GATE D2207-1 SETS TIMER FF D2208
							12	13	5	4	WRITE 15	FAST 10	STORE 7	NON-STORE [illegible]	
FAST	1	0	0	0	1	1	1	0	0	0	0	1	0	0	1
WRITE	0	1	0	1	0	1	0	1	0	0	1	0	0	0	1
STORE	0	0	1	1	1	1	0	0	1	0	0	0	1	0	0
MEM OFF	0	1	1	1	1	0	0	0	0	1	0	0	0	1	0

Fig. 6.14. Truth table of pushbutton switch Decoder

DUAL OSCILLATOR

The dual oscillator formed by operational amplifiers D2222 and D2221 produces two different square-wave output signals, both with a frequency of 100 Hz.
The output signal present on pin 7 of D2221 has a duty cycle that is adjustable between 0 and 30 %. This signal is used as the variable persistence pulse and in the WRITE mode it is applied to the amplifier that drives the front mesh of the c.r.t.

The output signal on pin 8 of D2221 has a duty cycle that is adjustable between 0 and 80 %. This signal is applied in the STORE mode to the amplifier that drives the flood gun accelerator electrode of the c.r.t.

On output pin 6 of D2222 a triangular signal of approximately 100 Hz is available. Because of the RC feed-back loop this operational amplifier functions as a 100 Hz master oscillator. This triangular output waveform is applied to the positive input (pin 5) of D2221. Via the PERSISTENCE control R16 and operational amplifier D2221/2, 3, 1 a variable d.c. level is applied to the nagative input (pin 6) of D2221. In this way, the duty cycle at the output (pin 7) of D2221 is adjustable between 0 and 30 % by means of R16.

The 100 Hz triangular waveform from the master oscillator D2222 is also applied to the positive input (pin 10) of D2221. Via the INTENS control R14 and operational amplifier D2221/12, 13, 14 a variable d.c. voltage is applied to the negative input (pin 9) of D2221. In this way, the duty cycle on output pin 8 of D2221 is adjustable between 0 and 80 % by means of R14.
This is operative in the STORE mode.

TIMER

In the WRITE and FAST modes, pulses need to be applied to the various electrodes of the c.r.t. at specific intervals and in the correct sequence after the ERASE pushbutton has been operated. The timer, comprising five delay units connected in cascade, provides delay times of 100 ms, 500 ms, 300 ms, 300 ms and 300 ms. On the outputs of inverters D2212, timing pulses are produced after 100 ms (pin 6), 600 ms (pin 4), 900 ms (pin 2), 1200 ms (pin 10) and 1500 ms (pin 12).

The timer is triggered at the moment that the depressed ERASE pushbutton is released, this moment being referred to as t_0. At the time t_0 a positive-going clock pulse reaches the clock input (pin 3) of D flip-flop D2208. This enables the flip-flop to come into the SET condition if the data input (pin 5) is high.
In the WRITE and FAST modes, this data is made high via D2207/1, 2, 3.

In the SET condition of D2208 flip-flop the Q output (pin 1) is high and therefore the input of the first timer section becomes high. This timer consists of R2211, V2206, buffer D2213/14, 15 and C2208.
At the time that the timer input becomes high, input 14 and output 15 of D2213 are low. Capacitor C2208 now charges via R2211; diode V2206 is not conductive.
After a time of 100 ms C2208 is charged sufficiently for input 14 of D2213 to detect a high level and output 15 of the timer also becomes high.

This high output is passed to the input of the next timer section (the 500 ms timer) which consists of R2222, V2207, D2213/11, 12 and C2209 and operates in the same way as the 100 ms timer section. The succeeding timers have identical networks, the difference in delay times being achieved by different values of the resistors that charge the capacitors.
These timing pulses are gated to give the following output waveforms:

Output Gate	**Logic Level**	**Duration after t_o**
D2211/10	high	100 ms
D2211/11	high	600 ms
D2214/11	high in WRITE mode low in FAST mode	900 ms
D2211/4	high	1200 ms
D2211/3	low in WRITE mode high in FAST mode	1500 ms

The output on D2217/pin 2 is the inverse of the signal on D2211/pin 3.

After receiving a high level on its clear input (pin 4) the flip-flop D2208 comes into the reset condition and its Q output (pin 1) becomes low. This results in the input of the 100 ms timer becoming low and C2208 rapidly discharges via V2206 to make output 15 of D2213 low. In turn, the 500 ms timer receives this low input and C2209 is discharged via V2207 and the output of this timer becomes low. This reset action is passed to the succeeding timers in a similar manner.

The D flip-flop D2208 receives a clear command under the following conditions:

a. If the oscilloscope is switched on, the MAINS ON PRESET circuit comprising R2314, C2231, V2251 and inverter D2217/7,6 generates a positive pulse for 550 ms. This pulse is necessary to give certain flip-flops in the storage section a defined preset value after switching on the instrument. D flip-flop D2208 received the 550 ms clear pulse on pin 4 via diode V2252.

b. In the WRITE mode, a clear pulse comes 1200 ms after flip-flop D2208 has been set. This pulse comes via D2207/8, 9, 10, D2207/12, 13,11 and V2205.

c. In the FAST mode, a clear pulse comes 100 ms after the sweep of the selected time-base has ended. This pulse is received via D2207/5,6,4, D2207/12,13,11 and V2205.

NOT BUSY SIGNAL

If the "not busy" line ($\overline{\text{BUSY}}$) is low, it prevents parts of the storage logic from responding to a change in the combination of the mode pushbuttons S24A, S24B, S24C. This line remains low if an erase/prepare - write - transfer cycle is occurring. The "not busy" signal comes from the inverting output (pin 2) of D flip-flop D2208 via diode V2224.

In the WRITE mode: for 1200 ms after t_o the cathode of D2224 is low and thus the "not busy" line is also low.

In the FAST mode: from t_o until 100 ms after the end of the time-base sweep the "not busy" line is also low.

ETB AND BTB PULSE GENERATOR

The End of Time-Base (ETB) and Beginning of Time-Base (BTB) pulse generator consists of D2223, a low-voltage to high-voltage translator, followed by NAND gates D2214/5,6,4 and D2214/1,2,3 AND gate D2209/12,13,11, and inverter D2212/14,15.

The generator produces in the FAST mode an output pulse on D2212 pin 15 at the end of the selected time-base, and an output pulse on D2209 pin 11 at the beginning of the selected time-base. The generator is only operative in the FAST mode because pin 15 is made high in this mode.

If the main time-base is selected for horizontal deflection, then input pin 5 of D2223 is high, and input pin 11 is low during the MTB sweep.

If the delayed time-base is selected for horizontal deflection, then input pin 5 of D2223 is low, and input pin 12 is low during the DTB sweep.

D2223 forms an interface between the time-base logic and the storage logic.
The output pulses from D2223 are selected by the logic gates and shaped by the differentiators C2227, R2267 (ETB pulse) and C2232, R2243 (BTB pulse).
At the end of the time-base sweep, a positive pulse with a fast risetime is present across R2267; the negative-going pulse at the start of the time-base is not used.

At the beginning of the time-base sweep, a positive pulse with a fast risetime is present across R2243; the negative-going pulse at the end of the time-base sweep is not used.

AUTO-ERASE TIMER

The auto-erase timer comprises the monostable multivibrator D2227, transistor V2216 and timing capacitor C2217.
In the FAST mode, this circuit generates pulses with an adjustable interval (3 ... 8 s). These pulses have the same result as the operation of the ERASE pushbutton. The repetition time of the pulses is adjustable with the VIEW TIME potentiometer R16. This potentiometer produces a voltage that charges timing capacitor C2217, which is connected to the trigger input (pin 8) of the monostable multivibrator D2227.

The multivibrator is able to trigger if pin 6 is made low; i.e. in the FAST mode. If the voltage on the timing capacitor has reached a certain value, D2227 is triggered and produces a positive pulse at output pin 10 for 1 ms. Transistor V2213 now becomes conductive for 1 ms and gives an erase pulse to pin 3 of D flip-flop D2208. Transistor V2216 also becomes conductive and discharges timing capacitor C2217.
In the MAX position of R16, switch S6 is closed and therefore transistor V2237 is conductive. Transistor V2216 is also conductive and short-circuits C2217 so that the timer is switched off. Erasure can now only take place if the ERASE button is operated.

STABILISATION PULSE GENERATOR

The generator itself consists of the transistors V2243 and V2244, which function together as an unijunction transistor. If the Q output (pin 1) of D flip-flop D2216 becomes high, timing capacitor C2228 can charge via R2246 and R2251. The charging of C2228 continues until a certain voltage is reached and V2243 and V2244 fire (become conductive). A discharge path is thus provided for C2228 and a low pulse is available at the base of V2243 and the collector of V2244. The oscillator produces pulses with a frequency of about 150 Hz and a duty cycle of about 0,07 %.

The D flip-flop D2216 switches the oscillator on the FAST mode 900 ms after releasing the ERASE button when a positive clockpulse is present on pin 3. The flip-flop switches the oscillator off when a clear pulse reaches pin 4 at the start of the time-base. When the instrument is switched on, a clear pulse of 550 ms is applied to pin 4 via D2253. This pulse is generated by the circuit comprising inverter D2217/7,6 and timing elements R2314 and C2231.
Pin 8 of AND gate D2209 is low in the FAST mode from 900 ms after the release of the ERASE button up to the beginning of the time-base sweep.
Pin 9 of AND D2209 gate is low in the FAST mode from 1500ms after the release of the ERASE button until the end of the time-base sweep.
As a result, pin 10 of D2209 is low from 900 ms after the ERASE button is released until the end of the time-base sweep. The stabilisation pulses are available on pin 11 of D2231 from 900 ms after t_0 until the start of the time-base. During the time-base sweep pin 11 is high.

TIME-BASE AND Z-AMPLIFIER CONTROL

The Z-amplifier is controlled by the storage logic via emitter-follower V2232, R2278 and V2267.
The time-base is controlled via V2232 and R2287.
This circuit is driven on the base of V2232 by a 100 ms timer comprising R2276, V2266, D2213/3,2 and C2244.
The direction of diode V2266 is such that this timer fuctions differently from the other timers: when the input becomes high, the output is high almost immediately. When the input becomes low, the output becomes low only after a delay time of 100 ms.
The input signal for this times comes from the discrete NAND gate comprising R2274 and the diodes V2261, V2262 and V2263. The following situations are possible.

WRITE mode: The cathodes of V2262 and V2263 are constantly high. Pin 8 of D2214 is also high. Pin 9 of this NAND gate is low for 1200 ms after the moment that the ERASE button is released. Therefore, output pin 10 is high during the same time. Thus, because of the 100 ms delay time, output pin 2 of D2213 is high for 1300 ms after the release of the ERASE pushbutton.

FAST mode: The cathode of V2261 and V2262 are constantly high. Pin 5 of D2203 is also high. Pin 6 of this NAND gate is high from 1500 ms after t_0 until the end of the time-base. Because of the 100 ms delay, output pin 2 of D2213 is low from 1600 ms after t_0 until the end of the time-base sweep.

STORE mode: The cathodes of V2261, V2262 and V2263 are constantly high and thus output pin 2 of D2213 is constantly high. In this mode, the electron beam in the c.r.t. is blanked by the storage logic.

NON-STORE mode (MEMORY OFF): The cathodes of V2261 and V2263 are constantly high. The cathode of V2262 is constantly low and thus the output pin 2 of D2213 is constantly low. In this mode, the electron beam in the c.r.t. is not blanked by the storage logic.

MISCELLANEOUS CIRCUIT ELEMENTS

In the FAST mode, the data input (pin9) of flip-flop D2229 is high.
At the end of the time-base sweep a positive clock pulse reaches pin 11 and the flip-flop reverts to the set condition: output Q (pin 13) becomes high. The 100 ms delay unit comprising R2302, V2228, D2228/9, 10, D2228/14,15 and C2238 is then activated. After 100 ms, a positive output pulse from the timer reaches the clear input (pin 10) of the flip-flop and resets it.
The 100 ms timer functions in the same way as the 100 ms, 500 ms and 300 ms timers that are already described.
In the FAST mode, the data input (pin 5) of D flip-flop D2229 is high.
The clock pulse reaches pin 3, 600 ms after the release of the ERASE pushbutton and the flip-flop comes in the set condition. Now the output Q (pin 1) becomes high. The 600 ms pulse is derived via inverter D2226/9,10 from the output of the 600 ms timer (D2211/pin 11). At the end of the time-base sweep the clear input (pin 4) becomes high and the flip-flop comes into the reset condition: output Q (pin 1) becomes low.

QUADRUPLE BILATERAL SWITCHES D2401, D2402 and D2403

Each integrated circuit contains four analogue switches (transmission gates).
Each switch has two input/output pins and an "active when high" control input. A high level on this control results in a low impedance bidirectional path between the two matching input/output pins.
A low level on the control input results in a high impedance path between the two matching input/output pins.
The following inputs/outputs and control pins are associated:

- Pin 13 controls the transmission gate between pins 1 and 2.
- Pin 5 controls the transmission gate between pins 3 and 4.
- Pin 6 controls the transmission gate between pins 8 and 9.
- Pin 12 controls the transmission gate between pins 10 and 11.

The transmission gates are used for applying the appropriate signal at the right moment to the inputs of the amplifiers that drive the storage electrodes of the c.r.t.
The control inputs of D2401, D2402 and D2403 are driven by the storage logic.
When such a control input is activated (high) the signal at the input of the gate is switched through the input of the relevant amplifier. This input signal can be adjusted in order to regulate the amplifier output voltage.

FAST MESH AMPLIFIER

The fast mesh amplifier comprises transistors V2402, V2403 operating as a differential input amplifier. The collector of V2403 is direct-coupled to V2408, which drives the complementary output transistors V2404 and V2407. Feedback is provided by resistor R2454.

When no input signals are present, the input to V2402 is provided by a +5.6 V line and the output potential to the fast mesh G11 on R2449 is constant at +140 V.

The amplifier output is controlled by the stabilisation pulses and by the image transfer signal. When stabilisation pulses are received the output is switched between +140 V and a value that is adjustable between 0 V and +15 V.
During the image transfer, the output voltage becomes a little lower; it is adjustable between —1 V and +15 V.

FRONT MESH AMPLIFIER

The front mesh amplifier consists of input transistors V2458, V2431 and the alternative output transistor pairs V2426, V2427 and V2421, V2422 (each pair is series-connected for high-voltage switching).

When input transistor V2458 is conducting (see WRITE and FAST mode descriptions), the V2431 also conducts. The collector potential of V2431 falls and switches off V2426, V2427. Diodes V2423, V2424 are blocked and output transistors V2421, V2422 now conduct to connect the front mesh G12 to +500 V.

When input transistor V2458 is non-conducting, V2431 is also switched off. The increase in its collector voltage results in output transistors V2426, V2427 conducting and V2421, V2422 are switched off. The front mesh is now connected via output transistor pair V2426, V2427 to the voltage on the output of the front mesh preamplifier. This preamplifier comprises transistors V2414, V2416, V2417, V2418, V2467 and the output complementary pair, V2412, V2413.

FLOOD GUN ACCELERATOR AMPLIFIER

The flood gun amplifier consists of a differential pair V2437, V2438, the collector output of V2438 being direct-coupled to the base of driver V2442.
In turn, the collector of this transistor is direct-coupled to the base of output transistor V2439. Feedback is provided by resistor R2512.

In the various modes, the output from R2504 to the flood gun accelerator, FGA, can be switched to one of three levels depending on the inputs, as follows:

a. With no input signal the base of V2437 assumes a slight positive potential determined by the feedback resistor R2512.
   In this condition, the output to the FGA is +20 V.

b. When the input to V2437 is earthed by the bilateral input switch D2401 (pin 4 to pin 3) then V2437 conducts further and tends to switch off V2438 and, in turn, V2442. The collector of V2242 goes positive and this increase in potential applied to the base of output transistor V2439 causes it to conduct heavily.
   In this condition (see WRITE and FAST mode description), the output to the FGA is at +50V.

c. When the input to V2437 is switched to +11.2 V by D2401 (pin 9 to pin 8) then this transistor is blocked. As a result, V2438 conducts and brings V2442 into conduction. The resulting drop in the collector voltage of V2242 is applied to the base of V2439 and switches off this transistor.
   In this condition (see STORE mode description), the output to the FGA falls to 0 V.

COLLIMATOR 1 AMPLIFIER

This amplifier, V2444, V2446, is a two-transistor feedback circuit.
With no signal input the output on R2517 to collimator 1 (C1) is at +30 V.

When an earth is applied via D2401 (pin 11 to pin 10) to input transistor V2444, it conducts less and the increase in its collector potential is applied to the base of V2446. As a result, this transistor conducts further. In this condition (see WRITE and FAST mode description), collimator 1 potential is increased to +90 V.

COLLIMATOR 3 AMPLIFIER

This circuit is almost identical to the collimator 1 circuit described.
The amplifier comprises transistors V2449 and V2451. The collimator 3 potential can be switched by an earth from D2401 (pin 1 to pin 2) from its normal +75V level to between +75V and +100V.
This can be adjusted by means of preset R2404 for the fast storage mode and R2481 for the write storage mode. R2481 and R2404 are switched into the circuit by switching transistors V2445 and V2440.

FLOOD-GUN CATHODE BALANCE

The balance between the two cathodes can be adjusted by means of R2549 for the fast storage mode and by means of R2480 for the write storage mode.
R2549 and R2480 are switched by means switching transistor V2435 and switching diode V2458.

COLLIMATOR 2 AMPLIFIER

This is a two-stage transistor amplifier, V2462, V2448, with a preset gain control R2523 in the base circuit of V2448.
The collimator 2 potential can be adjusted between the values of +30 V and +90 V. When there is no input via diode V2464 then the base of V2462 stands at a positive value determined by the +5.6 V line (FAST and STORE modes).

In the WRITE mode, pulses are received via V2419 and diode V2456 which are integrated by C2427. Depending on the setting of the PERSISTENCE control, the integrated potential on the base of V2462 is modified, and , in turn modifies the output potential to the collimator 2 electrode.

Pulse Generation and Control for Storage Modes

This section describes how the storage pulses are generated in the different positions of the pushbutton controls, STORE, WRITE, FAST, and their effects on the various circuit blocks described in the previous section. For a fuller explanation of the functions of any of these circuit blocks, the reader is referred to this section   Functions of Storage Circuit Blocks.

Before describing the various modes, a truth table is given in Fig. 6.14. which shows the generation of the decoding pulses for each of the modes.

WRITE MODE

See Fig. 6.15. for voltage waveforms.

When the WRITE pushbutton (S24B) is depressed, a logic 0 is applied to input 14 of inverter D2202 (and to input 4 of AND gate D2201) of the pushbutton switch decoder to give a logic 1 on D2202-15 output pin. This is applied to input 13 of AND gate D2201. Together with the logic ones on the other inputs, 11 and 12 (FAST and STORE pushbuttons normal), a logic 1 is produced on D2201-10. This logic 1 is applied directly to input 13 of quadruple flip-flop D2204 and to inverter D2202/7,6 to give a logic 0 on input 5 of flip-flop D2204.

With the FAST and STORE pushbuttons not selected the input conditions of AND gates D2201/3,4,5,6 and D2201/1,2,8,9 are such that the outputs are at logic 0 and logic zeros are applied to inputs 12 and 4 of flip-flop D2204.

The resulting logic 1 on input 13 of D2204 gives a logic 1 on output pin D2204-15, the WRITE output.

This decoded pushbutton switch output is used to control the WRITE mode functions of the storage logic circuits. It allows the required pulses to be applied to the various electrodes of the c.r.t. after operation of the ERASE pushbutton, S25.

In the WRITE mode, D2204-14 is at logic 0, which gives a logic 1 on AND gate D2207-3. This output provides the set input on D2208-5 for the flip-flop.
Therefore, when the ERASE pushbutton S25 is released the input, via R2202, to the clock, pin 3, produces a logic 1 on the Q output (pin 1) to trigger the timer circuit. As stated, the release time of the ERASE pushbutton is referred to as t_0.

The first section of the timer gives an output pulse on D2211-10 that lasts for 100 ms after t_0. This is routed via diode V2226 and R2486 to the emitter of transistor V2458 at the input of the front mesh amplifier. The 100 ms positive-going pulse is passed to the base of V2431, which conducts, shuts off series transistors V2426 V2427 and brings series transistors V2421, V2422 into conduction. In this way, the first erase pulse of 500 V, 100 ms is passed to the front mesh electrode. This erase pulse and the subsequent pulses that are generated in the WRITE mode are shown in Fig. 3.14.

After this first erase pulse; i.e. at the time t_0 + 100 ms, the front mesh potential drops to approximately 0 V, the voltage that is present on the output of the front mesh preamplifier; i.e. on R2474. This output condition is a result of the signal derived from the second section of the timer, which gives a positive output from D2211-11 for 600 ms. This is routed via inverter D2226/9,10, AND gate D2224/3,4,5,6, diode V2234 and inverter D2228/5,4 to the transmission gate input D2403-12. The output on D2403-11 is a 600 ms negative-going pulse that is adjusted by preset R2577 at the input of the front mesh preamplifier to give approximately 0 V on the front mesh after the first erase pulse; i.e. after V2431 is blocked at t_0 + 100 ms.
This 0 V signal on the output of the front mesh preamplifier is routed via series transistors V2426, V2427 to the front mesh.

In the MAX WRITE position, R2414 is used to adjust the front mesh potential to a value slightly higher than 0 V, to give the background illumination of the c.r.t. the optimum intensity.
When the PERSISTENCE control is not in the MAX position, the R2414 preset is switched out of circuit by transmission gate D2403/1,2,13. This is activated by a positive input to D2226/3,2, routed via D2231/5,6,4 and D2231/8,9,10.

The fourth section of the timer generates a positive-going pulse on AND gate output D2211-4, which is applied to AND gate input D2224-5. Between 600 ms and 1200 ms after t_0 this activates transmission gate D2402/2,1,13 via D2224-6.
The high level input on D2402-13 connects the +11.2 V on D2402-2 to D2402-1. The front mesh can be adjusted by trimmer R2427 to approximately +10 V, the second erase pulse;

After the end of this second erase pulse; i.e. at t_0 +1200 ms, dynamic erase pulses are applied to the front mesh. These pulses are derived from the dual oscillator. The frequency of these dynamic erase pulses is 100 Hz and the duty cycle lies between 0 and 30 % dependent upon the setting of the PERSISTENCE control R16. Operational amplifier D2221/2,3,1 together with its RC feedback network R2294, C2239 provides a variable d.c. level to the negative input of D2221-6 to produce this variable duty cycle. The positive input D2221-5 is provided by the 100 Hz triangular waveform from the feedback oscillator D2222/2,3,6. These dynamic erase pulses at output D2221-7 are applied to the input of AND gate D2224-8. As the WRITE input is logic 1 and the input on D2224-2 is also at logic 1 after the 1200 ms pulse, then these dynamic erase pulses are passed via D2224-9 and R2471 to transistor V2419 at the input of the front mesh preamplifier. Trimmer R2423 in the collector of V2419 is provided to adjust the amplitude of the erase pulses to approximately +8 V.
These dynamic erase pulses continue until the time that the ERASE pushbutton is again released (t_0). From t_0 until 1200 ms, these pulses are held off by the 1200 ms pulse, which holds input D2224-2 at logic 0.

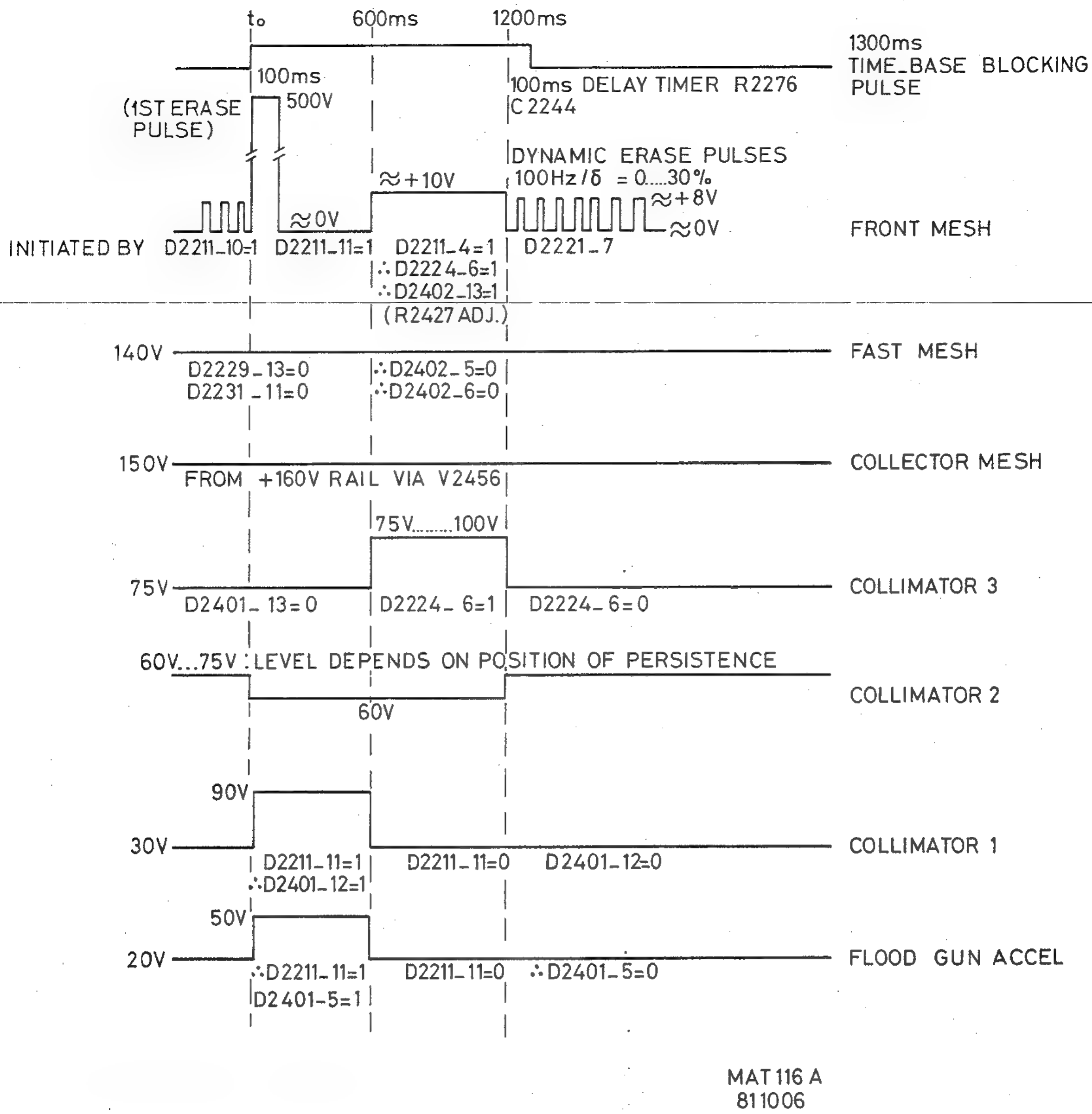


Fig. 6.15. Write mode — Composition of voltage waveforms on storage electrodes

Fast Mesh

In the WRITE mode the fast mesh is held permanently at +140 V during the erase/preparation - write - transfer cycle as there are no input control signals on D2402 pins 5 and 6. The input of the fast mesh amplifier is held at approximately +5.4 V via presets R2408 and R2412.

Collector Mesh

The collector mesh G10 remains at +150 V (in all modes), this potential being derived from the +160 V supply rail via diode V2457.

Collimator 3

The 3rd collimator is held at +75 V for the first 600 ms as control input D2401-13 is at logic 0. It is then switched to a value between +75 V and +100 V for the next 600 ms by a logic 1 on the output of AND gate D2224-6 (logic ones on all inputs). This logic 1 is routed via diode V2234 to control input D2401-13. After the end of the 1200 ms pulse the output of AND gate D2224-6 reverts to logic 0 and collimator 3 output drops to +75 V.

Collimator 1

At t_o, the positive pulse on control input D2401-12 applies the 0 V on D2404-11 to pin 10, and via R2403, to the base of V2444. As a result, the collimator 1 electrode potential is increased from +30 V to +90 V for the duration of the 600 ms pulse.

Flood Gun Accelerator

At the time t_o, the flood gun accelerator, normally at +20 V is increased to +50 V for 600 ms by a pulse from the second timer section D2211-11. This pulse is routed to control input D2401-5 to switch a +11.2 V input on pin 9 to pin 8 and, via R2402 to input transistor V2437 of the flood gun accelerator amplifier.

Collimator 2

The 2nd collimator is held at a potential of between +30 V and 90 V normally by preset R2523. However, the pulses from the PERSISTENCE control cause V2419 to conduct and diode V2464 conducts as its cathode is pulsed to the 0 V rail.
Depending on the position of the PERSISTENCE control, pulses with a duty cycle of between 0 and 30 % are routed via diode V2464 to modify the potential on integrating capacitor C2427 at the input of the collimator 2 amplifier.
This varies the potential on the collimator 2 electrode of the c.r.t. in proportion to the persistence time of the trace.

FAST MODE

See Fig. 6.16. for voltage waveforms.

When the FAST pushbutton (S24C) is depressed, a logic 0 is applied to input 3 of inverter D2202 (and to inputs 2 and 12 of AND gate D2201) of the pushbutton switch decoder, to give a logic 1 on output D2202-2. This is applied to AND gate input D2201-5. Together with the logic ones on the other two inputs, pins 4 and 3 (WRITE and STORE pushbuttons normal), a logic 1 is applied directly to D flip-flop input D2204-12 and to inverter D2202/5,4 to give a logic 0 on input D2204-5.

With the WRITE and STORE pushbuttons not selected, the input conditions of AND gates D2201/13,12,11,10 and D2201/2,1,8,9 are such that their outputs are at logic 0. Logic zeros are therefore applied to inputs 13 and 4 of flip-flop D2204.

The resulting logic 1 on input D2204-12 gives a logic 1 on output D2204-10, the FAST output.

This decoded pushbutton output is used to control the FAST mode functions of the storage logic circuits that provide the various pulses for the c.r.t electrodes after operation of the ERASE pushbutton S25.

In the FAST mode, D2204-11 output is at logic 0, which gives a logic 1 on output 3 of AND gate D2207. This provides the set input for flip-flop D2208. Therefore, on the release of the ERASE pushbutton S25 the positive clock input, via R2202 to pin 3 of D2208 gives a logic 1 on the Q output, pin 1.
This triggers the timer as in the case of the WRITE mode.

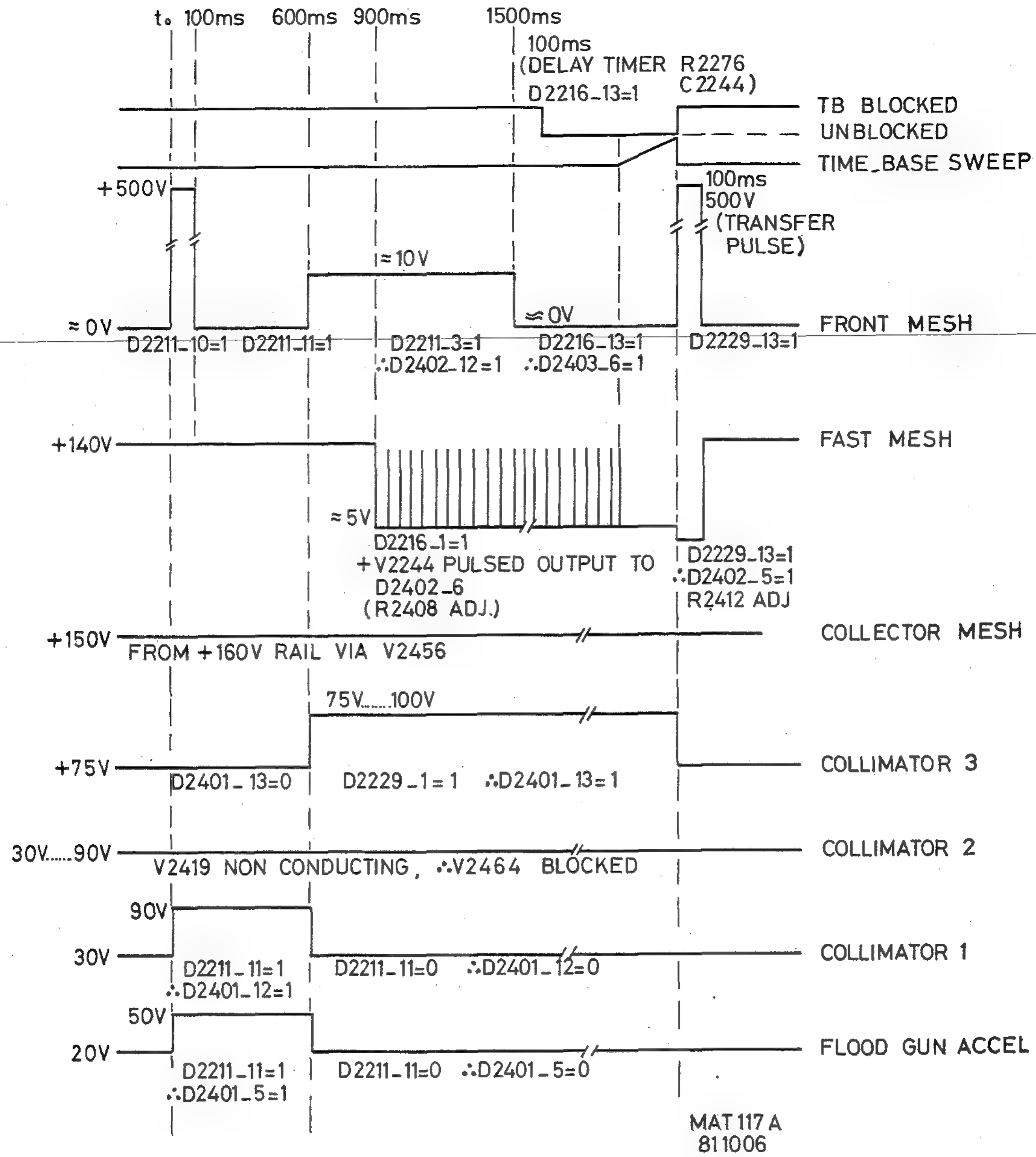


Fig. 6.16. Fast mode — Composition of voltage waveforms on storage electrodes

The first section of the timer provides the 100 ms pulse on D2211-10 immediately after the release of the ERASE pushbutton. This pulse is routed via diode V2226 and R2486 to the emitter of transistor V2458 at the input of the front mesh amplifier. As described in the WRITE mode, this positive-going 100 ms pulse is fed to the base of V2431, which conducts and cuts off series transistors V2426, V2427. Transistors V2421, V2422 conduct the 500 V first erase pulse and apply it to the front mesh.
At the end of the 100 ms pulse the potential of the front mesh reverts for 500 ms to approximately 0 V, the potential at the output of the front mesh preamplifier.

Also at the time t_0, the 600 ms pulse on output D2211-11 is routed to inputs 5 and 12 of the quadruple bilateral switches D2401. These switches control the inputs to the flood gun accelerator amplifier and the collimator 1 amplifier.
The positive-going pulse on control input D2401-5 switches the 0 V on pin 4 to pin 3. The resulting drop in potential at the base of V2437 causes the output transistor V2439 to conduct further, and the flood gun accelerator potential on R2504 is raised from +20 V to +50 V for the duration of the 600 ms pulse.
At t_0, the positive pulse on control input D2401-12 applies the 0 V on pin 11 via pin 10 and R2403 to the base of V2444, the input of the collimator 1 amplifier. Transistor switches off and the increase in its collector potential causes a further conduction of output transistor V2446. The collimator 1 potential increases from +30 V to +90 V as a result, for the duration of the 600 ms pulse.

At the end of the 600 ms pulse, collimator 3 is raised from 75 V to a value between +75 V and +100 V, adjustable by R2404, by a logic 1 on the Q output of flip-flop D2229 (FAST input on D and a clock pulse from D2226-10 after 600 ms). This logic 1 is routed via diode V2233 to control input D2401-13.
This applies the 0 V on pin 1 to the input of the collimator 3 amplifier, V2449, V2451.

The second erase pulse is generated after t_0 +600 ms and holds the front mesh at approximately +10 V for 900 ms. It is provided by the 1500 ms timing pulse derived from AND gate output D2211-3, which feeds a logic 1 to AND gate input D2224-13. Input 12 is also at logic 1 in the FAST mode and input 11 is at logic 1 at the end of the 600 ms pulse, therefore output D2224-10 is at logic 1.
This signal is fed to the control input of D2402-12, which connects the +11.2 V input on pin 10 to pin 11. The resulting +10 V second erase voltage is set by preset control R2429.

At the end of the second erase pulse the front mesh potential is lowered slightly to approximately 0 V until the transfer pulse at the end of the time-base sweep. This potential is initiated by the positive-going SET FRONT MESH input pulse to D2403-6, derived from the Q output of the D2216 flip-flop at t_0 + 1500 ms. This input logic 1 on D2403-6 switches the +11.2 V on pin 9 to pin 8, thereby increasing the input potential of the front mesh preamplifier slightly, thus reducing the output potential from +10 V to 0 V. Preset R2419 on the preamplifier input permits adjustment of this voltage.

Fast Mesh

During the preparation of the front mesh, the fast mesh potential is lowered from +140 V to +5 V at 300 ms after the start of the second erase pulse, i.e. at t_0 +900 ms. This is achieved by a positive pulse from flip-flop D2216 on output pin 1. The clock input of this flip-flop is derived from the $\overline{900}$ ms output of D2214-11.

The Q output from D2216 is routed via R2246 to an oscillator formed by timing capacitor C2228 and the complementary transistors V2243, V2244 (the stabilisation pulse generator). This provides 150 Hz pulses with a duty cycle of 0.07 % at input 12 of AND gate D2231.
Input 13 of D2231 is also at logic 1 for the period of t_0 + 900 ms until the end of the time-base sweep. This pulse is derived from the $\overline{Q}$ output of flip-flop D2216-2 which together with the Q output of D2216-12 is fed via AND gate D2209-10 and inverter D2228/3,2 to input D2231-13 as a logic 1. The pulses on output D2231-11 are routed via diode V2230 to control input 6 of transmission gate D2402. By this means, pulses are switched at 150 Hz from input 9 (+11.2 V) via output 8 to the base of V2402 at the input of the fast mesh amplifier. The low level of the input pulses is adjusted by preset R2408. Transistor V2402 conducts on the negative-going pulses, which results in negative-going pulses at the collector of V2403. These are inverted by V2408 and applied to the bases of the complementary output transistors V2404, V2407. The output on the junction of the emitters consists of the fast mesh preparatory pulses at a frequency of 150 Hz, positive-going from about +5 V to +140 V (duty cycle 0.07 %). The pulses are present until the begin of the time-base sweep.

Time-base

The time-base is unblocked at a time of 100 ms following the end of the second erase pulse; i.e. at t_0 + 1600 ms. This is achieved by the Q output of D2216-13 applied to input 6 of NAND gate D2203 at 1500 ms. Together with the FAST input on pin 5, this gives a logic 0 on D2203-4, which via V2263 lowers the input of the 100 ms

timer (R2276, V2266, D2213-3,2 and C2244). The timer output gives a low voltage after a delay of 100 ms; i.e. at 1600 ms. This pulse is fed via emitter-follower V2232 and resistor R2287 to unblock the time-base. The output from V2232 and diode V2267 controls the Z-amplifier.

After the time-base sweep, a 500V/100ms transfer pulse is fed to the front mesh. This image transfer pulse is derived from the Q output of flip-flop D2229-13. The clock input on pin 11 is fed from a differentiated pulse produced from the low-to-high voltage translator D2223 (see ETB, BTB pulse generator). The Q output of D2229-13 produces a 100 ms pulse because of the delay circuit R2302, V2228, D2228, C2238 coupled back to the clear input, D2229-10. This pulse is fed from D2228-15 to input 6 of NAND gates D2207. Together with the FAST signal D2207-5, a negative-going pulse is produced that is fed to the clear input of flip-flop D2208-4.
The output signal from D2229/13 is applied via diode V2227 to V2458 in the front mesh amplifier. Now the amplifier output is at +500V for 100ms after the end of the time base sweep.

At the same time as this transfer pulse, the Q output pulse from D2229-13 is also fed to the control input 5 of D2402, which switches a +11.2 V on input 3, via output 4 and preset R2412 to limit the conduction of V2402.
This slightly reduces the +5 V level on the fast mesh during the transfer pulse.

STORE MODE

See Fig. 6.17. for voltage waveforms.

When the STORE pushbutton (S24A) is depressed a logic 0 is applied to the input of inverter D2202-11 (and to the input of AND gates D2201/11 and D2201/3 of the pushbutton switch decoder to give a logic 1 on output D2202-12. This is applied to the input of AND gate D2201-8.

With the FAST and WRITE pushbuttons not selected, the input conditions of AND gates D2201/3,4,5,6, and D2201/11,12,13,10 are such that their outputs are at logic 0. Logic zeros are therefore applied to inputs 12 and 13 of flip-flop D2204. Input 4 of D2204 is also at logic 0 because input 1 of AND gate D2201 is at logic 0. However, since outputs 4, 6 and 10 of inverters D2202 are at logic 1, then diodes V2201, V2202 and V2203 are non-conducting and the combined input on pin 5 of flip-flop D2204 is at logic 1. This decoded input to D2204 gives a STORE signal (logic 1) on output pin 7, which is used to control the storage logic circuits in the STORE mode. This output condition also occurs if a faulty pushbutton combination is choosen.

In this mode, the flood gun accelerator anode is pulsed by a 100 Hz square wave derived from the dual oscillator formed by amplifier D2222. This produces a triangle input to amplifier D2221-10. The negative input on D2221-9 is supplied with a variable d.c. input from the INTENS control (R14) via operational amplifier D2221/12,13,14. In this way, a square wave output is produced on D2221-8, the duty cycle of which can be varied by the INTENS control between 0 and 80%. This waveform is inverted by D2217/9,10 and applied to the input of AND gate D2209-5. Together with the STORE signal on input 6, this produces an output on pin 4 to the control input of transmission gate D2401-6.
In this way, the +11.2 V input on pin 9 is pulsed via pin 8 and R2402, to the input of the flood gun amplifier. The base of V2437, normally at a small positive potential (at 20 V output) is driven more positive by the +11.2 V input pulses and V2437 is blocked during these pulses. Transistor V2438 conducts further as a result and drives the base of V2242 positive. This transistor conducts further and the resulting negative-going collector cuts off output transistor V2439.
As a result, its emitter drops to 0 V during the +11.2 V pulses from D2401-9. The output on the flood gun accelerator via R2504 consists of +20 V pulses with a duty cycle of 0–80% depending on the setting of the INTENS control.

During the STORE mode, the front mesh has a voltage that lies between –5 V and +15 V. This level is controlled by a logic 0 that is present on the output of AND gate D2224-6 (WRITE input 0). This logic 0 output, via V2234, produces a logic 1 on the output of inverter D2228/5,4, which is routed to the control input D2403-12. This connects a + 11.2 V supply from pin 10, via preset R2577, to the input of the front mesh preamplifier to give the store level between – 5V and + 15 V on the front mesh, G12.

Fast Mesh

The fast mesh is held at +140 V in the STORE mode. Output transistor V2404 of the fast mesh amplifier is held conducting because the base of the input transistor V2402 is held at approximately +5.4 V by the feedback via R2454.

No preparatory or transfer pulses are received in this mode to turn off V2402, therefore the output to the fast mesh remains at +140 V.

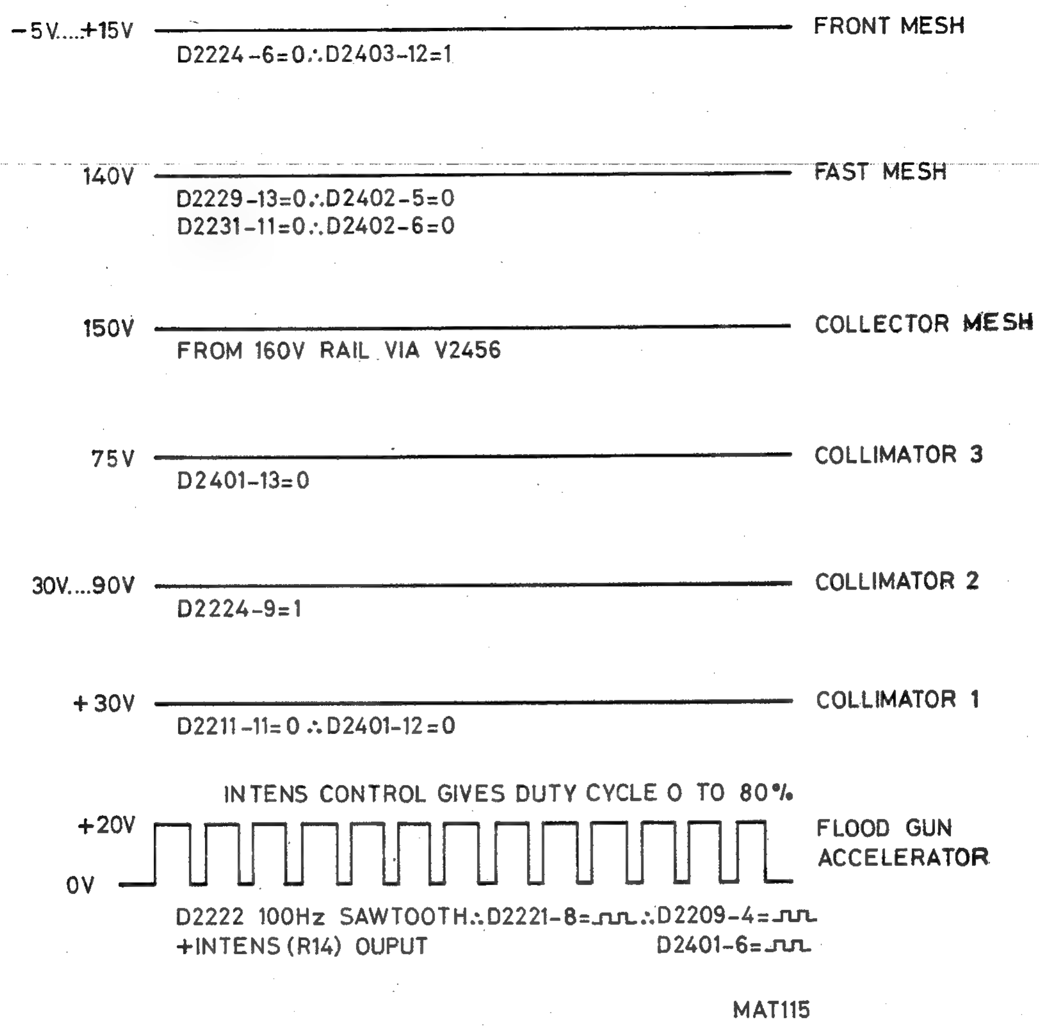


Fig. 6.17. Store mode — Composition of voltage waveforms on storage electrodes

Collector Mesh

The collector mesh G10 remains at +150 V in all modes, and this potential is derived from the +160 V supply rail via diode V2457.

Collimator 3.

The 3rd collimator is held at +75 V as control input D2401-13 is at logic 0. The earth potential is not switched to output D2401-2 and so the base of V2449 is held positive by the +5.6 V input via preset R2404. Transistor V2449 is therefore more conductive and limits the emitter output of V2451 to +75 V.

Collimator 2

The 2nd collimator is held at a potential between +30 V and +90 V.
In this mode, output 9 of AND gate D2224 is at logic 0 and therefore V2419 is non-conducting. The input of the collimator 2 amplifier is therefore at logic 1. Transistor V2462 conducts and the output of transistor V2448 is adjustable between +30 V and +90 V by preset R2523 in its base circuit.

Collimator 1

The 1st collimator is held at +30 V by means of the positive potential applied to the base of input transistor V2444 via feedback resistor R2518.

MEMORY OFF MODE

When both the WRITE and STORE pushbuttons (S24B, S24A) are depressed together, the MEM OFF or NON-STORE mode is selected.
Logic 0 is applied to input D2202-14 and D2202-11 (and to D2201 inputs 4, 3 and 11) to give logic ones on outputs D2202-15 and D2202-12. Input 1 and 8 of AND gate D2201 are therefore at logic 1, and also the input 2 is at logic 1 (FAST input at logic 1). Consequently, there is a logic 1 on output D2201-9, which feeds a logic 1 to flip-flop input D2204-4. This results in a logic 1 on the NON-STORE output D2204-2.

In this mode, all other inputs to the quadruple flip-flop D2204 are at logic 0, therefore the FAST, WRITE and STORE outputs are also at logic 0.

The logic 1 from D2204-2 is applied to control input D2403-5 to switch the +11.2 V on pin 3 to pin 4 and via R2418 to the base of V2414 at the input of the front mesh preamplifier. This transistor switches off and V2416 conducts, which in turn switches on V2418. The drop in its collector potential makes V2412 less conductive. The negative potential on R2474 is routed via series transistors V2427, V2426 and R2484 to give –35 V on the front mesh, G12.

The potentials to the fast mesh, the collector mesh and the collimators are the same as those for the STORE mode, and the flood gun accelerator is permanently at +20 V (i.e. no input connected from D2401).

6.10. Z-AMPLIFIER AND FOCUS AMPLIFIER

The current that determines the intensity of the spot on the c.r.t. screen is applied to the emitter of V2001 and is derived from several sources as follows:

- R2006: the current from this resistor is influenced by the setting of the INTENS control (R14) via V2002. In addition, it is influenced via V2003 by a signal applied to the EXT Z MODulation input X8.
- R2000: the signal applied to this resistor is dervived from the storage logic for display blanking during static erasure.
- R2002: the signal applied to this resistor is derived from the chopper oscillator (chopper blanking).
- R2001: the signal applied to this resistor is derived from the time-base unit for display blanking if the time-base does not run (time-base unblanking).

The circuitry in the input circuit of the Z-amplifier is arranged in such a way that - depending on the selected display function - the maximum Z-pulse is limited.
The Z-pulse is limited to such a value that maximum intensity will normally not damage the CRT.
However, to be completely safe the intensity control must be operated with care !

WARNING: IN ORDER TO PREVENT DAMAGE TO THE C.R.T. THE INTENSITY MUST NOT BE TOO HIGH.

The circuit that limits the Z-pulse amplitude is located on a small additional unit (unit 802) above the time-base unit.
The Z-pulse is controlled in the following way:

- The maximum Z-pulse in the X EXT mode is limited to 35 Volt because V1517 on the time-base (unit 8) is switched off.
  Now transistor V973 on unit 802 is switched off and R2009 on the Z-amplifier (unit 11) does not receive any current.

  In the MTB positions 1 s/DIV ... 5ms/DIV transistor V973 on unit 802 is switched off. Via a contact of the MTB switch the junction of R927 and R928 is applied to +5.2V and diode V972 on unit 802 becomes conductive so that V973 switches off.
- If the instrument is not used in the two situations described above the max. Z-pulse is 75 Volt in the SINGLE, FAST and magnifier X10 modes.

  In the SINGLE mode an earth potential coming from S8b (TRIG) and S8a (AUTO) is applied to the junction of R965 and R983 on the time-base unit. Therefore, the transistor V973 on unit 802 can become conductive and supplies current to R2009 on the Z-amplifier.

  In the FAST mode an earth potential is applied to the junction of R965 and R983 via diode V958.
  Now V973 on unit 802 can become conductive via diode V971.
  In the magnifier X10 mode V973 is made conductive by applying –5,2Volt to its emitter via K1701 on unit 26 and R991.

The current applied to the emitter of V2001 is used to determine the intensity and the focusing of the c.r.t. electron beam. As the focusting is influenced by the INTENS setting, the c.r.t. screen will show a well-focused spot over nearly the whole of the intensity range.
The signal from V2001 is applied to a differential amplifier comprising V2007 and V2008. The signals on the collectors of these transistors have a phase difference of 180 degrees.
The signal present on the colllector of V2007 is used to drive the focus amplifier consisting of V2032, V2028, V2023 and emitter-follower V2026.
The signal present on the collector of V2008 is used to drive the Z-amplifier consisting of V2018, V2021, V2016, V2012 and emitter follower V2013.

The output signal of the Z-amplifier is present on the emitter of V2013; this signal comprises h.f., l.f., and d.c. components. The h.f. component is applied to the Wehnelt cylinder G1 of the c.r.t. via d.c. blocking capacitor C2077. Grid G1 is at a potential of about –3kV.

The l.f. and d.c. components are applied to a modulator circuit V2038, V2037 and V2033. The trimming potentiometer R2064 permits intensity adjustment in order to compensate for c.r.t. tolerances.
The modulated signal is connected to the –3kV level at G1 via d.c. blocking capacitor C2076.
Demodulation is achieved by V2076, V2077 and matching capacitors. The demodulated l.f. and d.c. components are added to the h.f. component on the Wehnelt cylinder G1.
The c.r.t. has two focusing electrodes:
- G3 is used for horizontal focusing and the voltage is adjustable by R17 (fine) and R2024 (coarse).
- G5 is used for vertical focusing and the voltage is adjustable by R19.

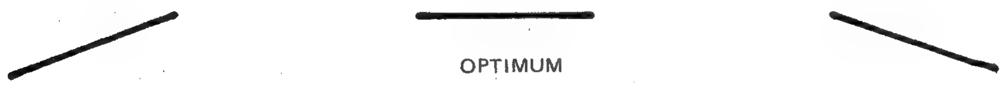
Control R17 is the FOCUS control on the instrument front panel: R19 is a trimming potentiometer located internally that is only adjusted initially. The output signal from the focus amplifier is present at the emitter of V2026. The h.f. component in this signal is applied viaC2083 and C2084 to G3 and G5 respectively. In addition, this output signal is equally divided between R2073 and R2134 in order to control the focusing electrodes G3 and G5. The voltage on G3 is controlled by the circuit comprising V2039, V2040 and V2043. Three transistors operating in series are used here to counteract the high voltage. The emitter current applied to V2039 is determined by the output signal from the focus amplifier (via R2073) and by the current from the potentiometers R17 and R2024. The voltage on G5 is controlled by the circuit comprising V2107, V2041 and V2042. V2041 and V2042 in series are also used here because of the high working voltage.
The base current applied to V2107 is determined by the output signal from the focus amplifier (via R2134) and by the current from the triming potentiometer R19.

CRT CATHODE VOLTAGE REGULATION

In order to prevent variations in the c.r.t. deflection sensitivities, the –3 kV cathode voltage is stabilised. Alternating current variations are applied via C2089 to an amplifier consisting of V2057, V2056 and V2073. Direct current variations are applied to this amplifier via R2086 and R2087. The collector voltage of V2073 compensates for the voltage variations of power supply and rectifier. Consequently, the cathode voltage remains independent of the cathode current.

CRT CONTROLS

TRACE ROTATION is achieved by means of the trace rotation coil. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan. The degree and direction of rotation is determined by the setting of potentiometer R15 (screw-driver operated, attainable via a ventilation hole in the left side panel of the instrument). The slider of R15 is connected to the bases of the complementary transistors V2063 and V2064. The trace rotation coil is supplied by these transistors.



With the GEOMETRY control R2103, the barrel and pin-cushion distortion is corrected by influencing the voltage on the grid G8.

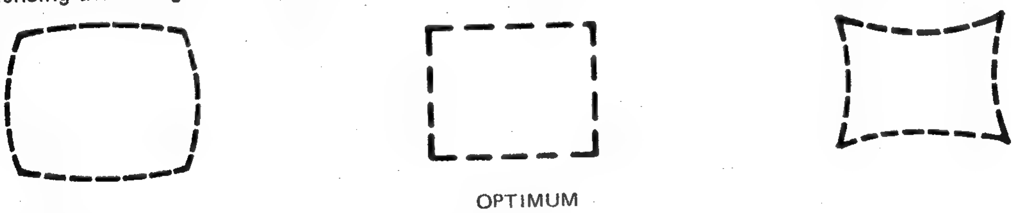


Fig. 6.18. CRT adjustments trace rotation and geometry

6.11. POWER SUPPLY AND CALIBRATION GENERATOR

Input circuit

The power supply input circuit is matched to the 115 V or 230 V range with selector-switch S1801 which is located at the power supply unit at the rear side.
The mains voltage is rectified with the diode bridge V1801 and C1802, C1803, which form a voltage doubler in the 115 V position of S1801, and a standard bridge rectifier circuit in the 230 V position of S1801.
The voltage across the series circuit of C1802 and C1803 amounts 250 to 400 V for both mains voltage ranges.

Switching circuit

The unregulated d.c. voltage is applied in the form of pulses to a resonance circuit consisting of the primary coil of the convertor transformer T1801, combined with C1807 and C1808, via switching transistor V1806.
The sine-wave voltage (approx. 800V p.p.) across the primary coil of T1801 is kept constant by regulating the duty cycle of the base current of V1806.
The primary coil of L1806 which is in series with the switching transistor, limits the current through this transistor.
The energy stored in L1806 is fed-back to the mains rectifier circuit, during the cut-off time of V1806, via diode V1811.
V1808 and V1809 keep the dissipation during the switching moments out of transistor V1806; instead of these losses are dissipated in R1814 and R1816.
V1807 improves the base drive for V1806.

Regulator circuit

The regulator circuit itself consists of integrated circuit D1801 (type TDA 1060), the output of which (p.15) supplies a square-wave current with variable duty-cycle to the base of V1812.
The duty-cycle of this signal is variable.
The collector signal of V1812 is applied to the switching transistor via transformer L1803.
The regulator circuit is controlled by:

- Feed-back voltage (p.3)
  This is the regulator control voltage and is taken from the rectifier circuit at the feed-back winding of T1801.
  This control voltage depends on the setting of R1826 (V out).

- Over-voltage protection (p.13)
  This voltage is also derived from the mains voltage and inhibits the regulator output at too high mains voltages (the trip-level on p.13 is 600 mV).
- Current limit (p.11)
  The voltage drop across the current-sense resistor R1811 controls the regulator circuit in case of overload.

- Frequency (p.7)
  The resistance between p.7 and ground estimates the convertor frequency.
  R1827 (Freq.) has been adjusted to obtain a frequency of 20 kHz.
  The resonance frequency of C1807, 1808 and the primary coil of T1801 is wide enough to tolerate this.

Under normal working conditions the power supply voltages for the regulator circuit are delivered by the rectifier connected to the feed-back winding of T1801.
V1804 is then conducting so that V1803 does not deliver current.

Switching-on

When switching-on the instrument, no supply voltages are available in the regulator circuit, from T1801.
At this moment V1804 is not conducting, so that V1803 is fully conducting, and the regulator circuit gets current via R1804 and R1806.
As soon as the converter circuit is working V1804 becomes conducting and V1803 is not conducting anymore.

Switching-on protection

If the instrument is switched-on and no convertor voltage would appear (due to a possible defect) the PTC resistor R1806 will warm up, reducing the current through V1803 to a safe low value.

Output circuits

The output rectifiers are of the coil-input types delivering the mean value of the sine-wave transformer voltages across the output capacitor. Except the d.c. voltages the convertor transformer delivers also:

- 6,3 V (not used)
- 1 kV - 1,5 kV for the focus and high tension circuits
- 120 V for the additional power supply unit.

Photo-coupler circuit

This circuit delivers a sine-wave voltage (derived from the mains voltage) used for mains triggering or mains deflection.
The photo-coupler V1842 which provides isolation between the mains voltage and the oscilloscope's circuitry drives the V1843-circuit in saturation, so that the square-wave voltage at the collector of V1843 has the same value for all mains voltages.
With an integration network R1851, 1852, 1853 and C1836, 1837,1838 the original sine-wave is obtained.
Via V1844 and V1846 this signal is applied to the trigger source selection

Calibration circuit (see storage section circuit diagram)

The calibration unit is a square-wave generator consisting of an operational amplifier D1901 with feedback.
The oscillator frequency is determined by resistor R1909 and capacitor C1903. Capacitor C1902 keeps point 3 of the IC constantly equal to the average output voltage. Consequently, the generator is independent of fluctuations in the supply voltage. The square-wave amplitude is determined by zenerdiode V1901.
Potentiometer R1906 allows accurate adjustment of the output voltage and output current.
This output voltage is fed to socket X1 and the output current flows through current loop X2. This is the front panel CAL terminal.
The calibrator output signal can be used for probe compensation and/or checking the vertical deflection accuracy.

7. DISMANTLING THE INSTRUMENT

7.1. WARNING

> The opening of covers or removal of parts, except those of which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
> The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
> If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.
> Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

7.2. REMOVING THE COVERS AND SCREEN BEZEL

Both upper and lower cabinet plate can be removed after slackening one or two turns the four quick-release fasteners at the corners of each plate. Do not slacken the fasteners more than two turns, otherwise they may come apart.

The screen bezel can be detached by pressing the longer edges and pulling it out the front panel.

7.3. ACCESS TO PARTS NECESSARY FOR CHECKING AND ADJUSTING

Most of the adjustment points can be reached after removal of the top and bottom covers of the instrument (see section 9).
However at the bottom side the Z-amplifier (unit 11), focus unit (unit 7) and EHT multiplier (unit 15) are covered by a black metal screening plate. This plate is provided with holes that align with adjustment points on the Z-amplifier and the output voltage adjustment point of the power supply (R1826/unit 5).
For adjustment, always use an *insulated adjustment tool.*
If it is necessary to reach resistors on the Z-amplifier for measuring or adjustment purposes, the screening plate can be removed after slackening four screws.

Warning: note that after removal of this cover parts are accessible that carry dangerously high voltages.

8. CHECKING AND ADJUSTING

WARNING

> The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
> The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
> If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.
> Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

8.1. GENERAL INFORMATION

8.1.1. Introduction

The following information provides the complete checking and adjusting procedure for the oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary.
The procedure is, therefore, presented in a sequence that is best suited to this order.
Before any check or adjustment, the instrument must attain its normal operating temperature.

- Where possible, instrument performance is checked before an adjustment is made.
- Warming-up time under average conditions is 30 minutes.
- All limits and tolerances given in this section are calibration guides and should not be interpreted as instrument specifications unless they are also published in section 1.2. characteristics.
- Tolerances given are for the instrument under test and do not include test equipment error.
- The most accurate display adjustments are made with a stable, well-focused, low-intensity display.
- Unless otherwise noted, adjust the Intensity, Astigmatism, Focus, and Trigger Level controls as needed.

8.1.2. Recommended test equipment

Required instrument	Specifications	Example of required instrument
Square-wave generator	1 Hz – 50 MHz Constant amplitude of 10 mV – 30 V, rise-time ⩽ 1n sec duty cycle 50%	–
Sine-wave generator	1 Hz – 100 MHz Constant amplitude of 10 mV – 30 V	–
Time mark generator	1 sec. –50 n.sec in 23 calibrated positions in a 1-2-5 sequence	–
Digital multimeter	Wide voltage, current and resistance ranges	Philips PM 2527
Variable mains transformer	180 V – 265 V~	Philips 2422 529 00005
Oscilloscope	100 MHz	Philips PM 3262
Dummy probe	2:1, R = 1 MΩ, C = 15 pF	see Fig. 5.6.
Low capacitance trimming tools		Philips 800NTX
High tension probe	Voltage range min 2500 V input resistance min 100 MΩ	Philips 9246 A

8.1.3. Preliminary control settings

All preset potentiometers and trimming capacitors are indicated in the figures 8.8. and 8.9.

- Push the Y POSITION control to the NORM position.
- Depress push-buttons DC of the signal-coupling controls.
- Set the DELAY TIME control (R1) to 0 (fully anti-clockwise)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the TB MAGN control to position x1.
- Depress push-button AUTO of the trigger mode controls.
- Set the MAIN TIME/DIV switch to 1 ms
- Set the DEL'D TIME/DIV switch to OFF
- Set the TIME/DIV vernier controls to CAL.
- Depress push-buttons DC of the trigger-coupling controls
- Depress push-buttons A of the trigger-source controls (S21, S22).
- Except for the adjustment of the storage function (3.4.16.) the adjustments are carried out in the MEMORY OFF mode.

8.2. SURVEY OF ADJUSTING ELEMENTS

ADJUSTMENT AND ADJUSTING SEQUENCE	ADJUSTING ELEMENT	MEASURING VALUES + EXPLANATION	MEASURING INSTRUMENT	CHAPTER	FIGURES
Power supply					
Power consumption	–	$\leqslant$50W	Moving-iron meter	8.3.1.1.	–
+12,7V supply voltage	R1826 (UNIT 5)	+12,7V ± 100mV	Digital multimeter	8.3.1.2.	12.4.
Oscillator frequency	R1827 (UNIT 5)	+12,7V ± 100mV	Digital multimeter	8.3.1.3.	12.4
Supply voltages unit 12	R1654 (UNIT 12) R1673 (UNIT 12)	+11,4V b 100mV –11,4V ± 100mV	Digital multimeter Digital multimeter	8.3.1.4. 8.3.1.4.	8.8. 8.8.
Supply voltages unit 8	R1549 (UNIT 8)	+5,2V ± 100mV	Digital multimeter	8.3.1.4.	8.9.
Cathode voltage	R2123 (UNIT 11)	150V ± 3V	Digital multimeter	8.3.1.5.	8.8.
Calibration socket					
CAL voltage	R1906 (UNIT 22)	3V ± 1%	Oscilloscope	8.3.2.	8.8.
CAL frequency	–	2kHz ± 2%	Oscilloscope	8.3.2.	–
CRT circuit					
Focus	R2024 (UNIT 11)	Form of the spot	Sine-wave generator	8.3.3.1.	8.8.
Horizontal intensity	R2102 (UNIT 25)	Intensity of time-base line	–	8.3.3.1.	8.9.
Trace rotation	R15 (left side pannel)	Horizontal trace	–	8.3.3.2.	8.9.
Orthogonality	R1737 (UNIT 26)	Check for distortion	Sine-wave generator	8.3.3.3.	8.9./8.1.
Geometry	R2103 (UNIT 26)	Check for display without barrel and pin-cushion distortion	Sine-wave generator	8.3.3.4.	8.9./8.2.
Intensity	R2064 (UNIT 11)	Barely visible dot at beginning of trace	–	8.3.3.5.	8.8.
Intensity ratio	R1537 (UNIT 8)	Barely visible MTB trace and DTB trace mode brilliant	Sine-wave generator	8.3.3.6.	8.9./8.3.
Balance adjustments					
O-DC balance	R124 CH.A. (UNIT 2) R174 CH.B (UNIT 2)	Minimum trace jump when switching O-DC Minimum trace jump when switching O-DC	– –	8.3.4.1.	8.8.
Attenuator balance	R129 CH.A (UNIT 2) R179 CH.B. (UNIT 2)	Minimum trace jump when switching 5V/DIV - 10mV/DIV Minimum trace jump when switching 5V/DIV - 10mV/DIV	– –	8.3.4.2.	8.8.
Continue balance	R211 CH.A. (UNIT 12) R311 CH.B. (UNIT 12)	Minimum trace shift when turning the continuous control Minimum trace shift when turning the continuous control	– –	8.3.4.3.	8.8.
Balance 5mV/DIV	R216 CH.A. (UNIT 12) R316 CH.B. (UNIT 12)	Minimum trace jump when switching between 5mV/DIV - 10mV/DIV Minimum trace jump when switching between 5mV/DIV - 10mV/DIV	– –	8.3.4.4.	8.8.
Polarity balance	R259 CH.A. (UNIT 12) R359 CH.B. (UNIT 12)	Minimum trace jump when switching Normal-Invert Minimum trace jump when switching Normal-Invert	– –	8.3.4.5.	8.8.

ADJUSTMENT AND ADJUSTING SEQUENCE	ADJUSTING ELEMENT	MEASURING VALUES + EXPLANATION	MEASURING INSTRUMENT	CHAPTER	FIGURES
Trigger balance MTB	R881 (UNIT 9)	Starting point trace may not change when operating the +/- SLOPE switch.	Sine-wave generator	8.3.4.6.	8.8./8.9.
	R845 (UNIT 9)		Sine-wave generator		
	R431 (UNIT 12)	Trace must remain in the screen centre	–		
	R481 (UNIT 12)	Trace must remain in the screen centre	–		
	R729 (UNIT 16)	Trace must remain in the screen centre	–		
	R527 (UNIT 12)	Starting point to central horizontal graticule line	Sine-wave generator		
	R1523 (UNIT 8)	Point to central vertical graticule line	–		
	R737 (UNIT 16)	Point to first vertical graticule line	–	8.3.4.6.	8.8./8.9.
Trigger balance DTB	R1238 (UNIT 9)	D.T.B LEVEL adjustment	Sine-wave generator	8.3.4.7.	8.8./8.9.
	R428 (UNIT 12)	Starting point in the centre of the screen	Sine-wave generator		
	R478 (UNIT 12)	Starting point in the centre of the screen	Sine-wave generator	8.3.4.7.	8.8./8.9.
Y position correction	R658 (UNIT 13)	Trace exactly in the centre of the screen	–	8.3.4.8.	8.9.
	R500 (UNIT 12)	Trace exactly in the centre of the screen	–	8.3.4.8.	8.8.
	R500 (UNIT 12)	Minimum trace jump-ALT and ADD depressed	–	8.3.4.8.	8.8.
Time-base MAGN balance	R1749 (UNIT 26)	No movement starting when operating TB MAGN	–	8.3.4.9.	8.9.
Time-base generators					
MTB time-coefficients	R1709 (UNIT 26)	1ms range	Time-marker generator	8.3.5.1.	8.9.
	R913 (UNIT 8)	5ms range	Time-marker generator		
	R911 (UNIT 8)	1μs range	Time-marker generator		
	R1706 (UNIT 26)	TB MAGNIFIER	Time-marker generator		
	C916 (UNIT 8)	0,1μs range	Time-marker generator		
	C1703 (UNIT 26)	0,05μs range + MAGN. X10	Time-marker generator	8.3.5.1.	8.9.
DTB time-coefficients	R1326 (UNIT 8)	1ms range	Time-marker generator	8.3.5.2.	8.9.
	R1318 (UNIT 8)	5ms range	Time-marker generator		
	C1321 (UNIT 8)	1μs range	Time-marker generator		
	C1311 (UNIT 8)	0,1μs range	Time-marker generator	8.3.5.2.	8.9.
Delay time	R1384 (UNIT 9)	Start	Time-marker generator	8.3.5.3.	8.9.
	R1379 (UNIT 9)	Stop	Time-marker generator	8.3.5.3.	8.9.
ALT TB and trace separation	TRACE SEP (R6 front)	Distance between traces 0 DIV.	–	8.3.5.4.	–
		Distance between traces 4 DIV.	–	8.3.5.4.	–
L.F. correction and sensitivities					
L.F. correction amplifier (attenuator unit)	R132 CH.A. (UNIT 2)	Check that the pulse top is straight	Square-wave generator	8.3.6.1.	8.8.
	R182 CH.B. (UNIT 2)	Check that the pulse top is straight	Square-wave generator		
LF correction MTB external input	R736 (UNIT 16)	Check that the pulse top is straigt	Square-wave generator	8.3.6.2.	8.8.
LF correction DTB external input	R1118 (UNIT 16)	Check that the pulse top is straight	Square-wave generator	8.3.6.3.	8.8.

ADJUSTMENT AND ADJUSTING SEQUENCE	ADJUSTING ELEMENT	MEASURING VALUES + EXPLANATION	MEASURING INSTRUMENT	CHAPTER	FIGURES
Gain YA VIA Y	R654 (UNIT 13)	Adjust for a trace height of 6 div.	Square-wave generator	8.3.6.4.	8.9.
Gain YB VIA Y	GAIN (R13 front)	Adjust for a trace height of 6 div.	Square-wave generator	8.3.6.5.	–
Gain at external X deflection	R742 (UNIT 16)	Adjust for a trace height of 6 div.	Square-wave generator	8.3.6.6.	8.8.
Gain external triggering via TRIG VIEW	R842 (UNIT 9)	Adjust for a trace height of 6 div.	Square-wave generator	8.3.6.7.	8.9.
Gain YA TRIG VIEW	R413 (UNIT 12)	Adjust for a trace height of 6 DIV ± 3 SUB. DIV.	Square-wave generator	8.3.6.8.	8.8.
Gain YB TRIG VIEW	R463 (UNIT 12)	Adjust for a trace height of 6 DIV ± 3 SUB. DIV.	Square-wave generator	8.3.6.9.	8.8.
Gain YA VIA X	–	Check that the trace width is 6 DIV ± 0,3 DIV	Square-wave generator	8.3.6.10.	–
Gain YB VIA X	–	Check that the trace width is 6 DIV ± 0,3 DIV	Square-wave generator	8.3.6.11.	–
Vertical channels					
Square-wave response (attenuator unit)	C107 CH.A. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%	Square-wave generator	8.3.7.1.	8.8.
	C157 CH.B. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%	Square-wave generator		
	C112 CH.A. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%	Square-wave generator		
	C162 CH.B. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%	Square-wave generator	8.3.7.1.	8.8.
Input capacitance	C101 CH A. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%			
	C151 CH.B. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%			
	C104 CH.A. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%	Square-wave generator and 2 : 1 dummy probe	8.3.7.2.	8.8./8.4.
	C154 CH.B. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%			
	C109 CH.A. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%			
	C159 CH.B. (UNIT 2)	Check that pulse top errors do not exceed +/- 3%			
Square-wave response final Y-amplfier	R634 (UNIT 13)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.3.	8.9./8.8.
	C613 (UNIT 13)	Adjust for optimal square-wave response	Square-wave generator		
	R636 (UNIT 13)	Adjust for optimal square-wave response	Square-wave generator		
	C614 (UNIT 13)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.3.	8.9./8.8.
Square-wave response channel A	C257 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.8./8.9.
	C229 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R253 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R254 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C227 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C228 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C224 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R244 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C233 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R646 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C215 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.8./8.9.

ADJUSTMENT AND ADJUSTING SEQUENCE	ADJUSTING	MEASURING VALUES + EXPLANATION	MEASURING INSTRUMENT	CHAPTER	FIGURES
Square-wave response channel B	R357 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.8.
	C329 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R353 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R354 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C327 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C328 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C324 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R344 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C333 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C315 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.8.
Bandwith check	–	Check for 100MHz bandwidth	Sine-wave generator	8.3.7.6.	–
Common-mode rejection	–	Check according to table	Sine-wave generator	8.3.7.7.	–
Dynamic range and position range	–	Check distortion	Sine-wave generator	8.3.7.8.	–
Chopped mode	–	Check chopper function	–	8.3.7.9.	–
Alternate mode	–	Check alternate function	–	8.3.7.10.	–
Square-wave response trigger view via EXT	C819 (UNIT 9)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.11.	8.8./8.9.
	C714 (UNIT 16)	Adjust for optimal square-wave response	Square-wave generator		
Square-wave response trigger view via CH.A.	R409 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.12.	8.8.
	C404 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C407 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C411 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C408 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	R416 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator		
	C411 (UNIT 12)	Adjust for optimal square-wave response	Square-wave generator	8.3.7.12.	8.8.
Square-wave response trigger view via CH.B.	C459 (UNIT 12)	Adjust for square-wave response	Square-wave generator	8.3.7.12.	8.8.
	C454 (UNIT 12)	Adjust for square-wave response	Square-wave generator		
	C457 (UNIT 12)	Adjust for square-wave response	Square-wave generator		
	C461 (UNIT 12)	Adjust for square-wave response	Square-wave generator		
	C458 (UNIT 12)	Adjust for square-wave response	Square-wave generator		
	C466 (UNIT 12)	Adjust for square-wave response	Square-wave generator		
	C461 (UNIT 12)	Adjust for square-wave response	Square-wave generator	8.3.7.12.	8.8.
Bandwith trigger view via channel A (B)	–	Check bandwith	Sine-wave generator	8.3.7.13.	–
Bandwith trigger view via external input	–	Check bandwith	Sine-wave generator	8.3.7.14.	–

ADJUSTMENT AND ADJUSTING SEQUENCE	ADJUSTING	MEASURING VALUES + EXPLANATION	MEASURING INSTRUMENT	CHAPTER	FIGURES
Triggering					
Trigger slope and level of the MTB	R881 (UNIT 9)	Starting point trace may not change when operating the +/- SLOPE switch.	Sine-wave generator	8.3.8.1.	8.9.
	R845 (UNIT 9)	Check the LEVEL function	Sine-wave generator	8.3.8.1.	8.9.
Trigger sensitivities MTB	—	Check according to table	Sine-wave generator	8.3.8.2.	—
Single sweep operation	—	Check single sweep function	Sine-wave generator	8.3.8.3.	—
Triggering at mains frequency	—	Check for a stable display	—		
Trigger slope and level of of the DTB	—	Starting point trace may not change when operating the +/- SLOPE switch.	Sine-wave generator	8.3.8.4.	—
	—	Check the LEVEL function	Sine-wave generator	8.3.8.5.	—
Trigger sensitivities DTB	—	Check according to table	Sine-wave generator	8.3.8.6.	—
Jitter	—	Check for a jitter free display	Sine-wave generator	8.3.9.	—
Periodic and random deviations	—	Check according to table	—	8.3.10.	—
Effect of the mains voltage variations	—	Check	Variable mains transformer	8.3.11.	—
Horizontal amplifier					
Bandwidth	—	Check bandwidth	Sine-wave generator	8.3.12.1.	—
Phase difference	—	Phase difference less than 3^{o}	Sine-wave generator	8.3.12.2.	—
Storage section					
(MAX) Write mode	R2523 (UNIT 25)	Fully clockwise	—	8.3.13.4.	8.9.
	R2427 (UNIT 25)	Fully counter-clockwise	—	8.3.13.4.	8.9.
	R2404, R2423, R2480, R2481, R2549 (UNIT 25)	Put in mid position	—	8.3.13.4.	8.9.
	R2423 (UNIT 25)	Adjust pulse on pin 12 on unit 25 to 8 Volt	—	8.3.13.4.	8.9.
	R2577 (UNIT 25)	Adjust bottom level of pulse on pin 12 of unit 25 to 0 Volt.	—	8.3.13.4.	8.9.
	R2523 (UNIT 25)	Borders of illuminated area on CRT must be just invisible.	—	8.3.13.4.	8.9.
	R2427 (UNIT 25)	After erasure CRT screen must be just black.	—	8.3.13.4.	8.9.
	R2414 (UNIT 25)	Adjust background illumination after erasure in max. write mode.	—	8.3.13.4.	8.9.
	R2480 (UNIT 25)	Adjust flood gun balance	—	8.3.13.4.	8.9.
Check writing speed in write mode	—	Apply input signal 2,5kHz/32 DIV.	Sine-wave generator	8.3.13.4.	8.9.
	R2481 (UNIT 25)	Intensity of written in signal must be equal over whole screen	—	8.3.13.4.	8.9.
Check writing speed in max. write mode	—	Apply input signal 25kHz/32 DIV.	Sine-wave generator	8.3.13.4.	8.9.

ADJUSTMENT AND ADJUSTING SEQUENCE	ADJUSTING ELEMENT	MEASURING VALUES + EXPLANATION	MEASURING INSTRUMENT	CHAPTER	FIGURES
Fast mode	R2408, R2412, R2419, R2429 (UNIT 25)	Fully counter - clockwise	–	8.3.13.5.	8.9.
	R2429 (UNIT 25)	After erasure CRT screen must be nearly just black	–	8.3.13.5.	8.9.
	R2412 (UNIT 25)	Adjust so that input signal just becomes visible	Sine-wave generator	8.3.13.5.	8.9.
	R2404 (UNIT 25)	Adjust so that background illumination is equal over whole screen.	Sine-wave generator	8.3.13.5.	8.9.
	R2549 (UNIT 25)	Adjust flood gun balance	–	8.3.13.5.	8.9.
	R2408 (UNIT 25)	Adjust so that intensity of written in picture does not decrease if written in 1 min. after erasure.	Sine-wave generator	8.3.13.5.	8.9.

8.3. CHECKING AND ADJUSTING PROCEDURE

8.3.1. Power supply

8.3.1.1. Power consumption

- Check that the voltage has been set to the local mains voltage and connect the instrument to such a voltage.
- Switch the oscilloscope on and check that the pilot lamp on the front panel lights up.
- Check that the power consumption does not exceed 50W (measured with a moving-iron meter).

WARNING: **Use an isolated adjustment tool when carrying out adjustments on the power supply (unit 5).**

REMARK: **If present, remove C1827 that may be connected in parallel with C1826 on unit 5. C1827 is not required in the PM3266. C1827 may be present on A replacement unit 5 that replaces the old one.**

8.3.1.2. +12,7V supply voltage (unit 5)

- Check at nominal mains voltage that the voltage on the positive pole of C1831 is + 12,7V ± 100mV; if necessary, readjust potentiometer R1826 on the power board.
- Check that this voltage does not vary more than ± 50mV when the mains voltage is varied between –10% and + 20%.

8.3.1.3. Pre-set potentiometer R1827 (FREQ.)

This potentiometer is a factory adjustment control. THE SETTING OF THIS POTENTIOMETER MUST NOT BE DISTURBED UNLESS IT IS ABSOLUTELY IMPOSSIBLE TO SET THE + 12,7V WITH THE AID OF POTENTIOMETER R1826.

Adjusting procedure:

- Set the mains input voltage to 220V
- Turn potentiometer R1827 fully anti-clockwise
- Check that the voltage on the positive pole of C1831 is +12,7V ± 100mV; if necessary; readjust potentiometer R1826 on the power supply board.
- Set the mains input voltage to 170V
- Check that the voltage on the positive pole of C1831 is +12,7V ± 100mV; if necessary; readjust potentiometer R1827 on the power supply board.

8.3.1.4. Supply voltages for unit 8 and unit 12

- Adjust R1654 on unit 12 for a correct +11,4Volt (± 100mV) across C1653.
- Adjust R1673 on unit 12 for a correct –11,4Volt (± 100mV) across C1661.
- Adjust R1549 on unit 8 for a correct +5,2Volt (± 100mV) across V1562/emitter.

8.3.1.5. CRT cathode voltage (unit 11)

- Check that the voltage on the collector of V2073 on unit 11 (Z-amplifier) is 150Volt (± 3Volt).
- If necessary, readjust potentiometer R1223 on unit 11.

8.3.2. Calibration socket

If necessary, check the supply voltages first, refer to section 8.3.1.

- Check the calibration square wave on irregularities
- Check that the amplitude of the CAL voltage is 3 V ± 1 %; if necessary, readjust potentiometer **R1906** on the storage logic (unit 22).
- Check that the frequency of the CAL voltage is 2 kHz, ± 2 %
- Check that the CAL current is 6 mA ± 1 %.

8.3.3. Cathode-ray tube circuit

8.3.3.1. Focus and horizontal intensity.

- Check that the controls occupy the positions indicated in section 8.1.3.
- Depress pushbutton A of the vertical display mode selector (S1).
- Apply a sine-wave signal with the frequency of 100 kHz to input A.
- Adjust the trace height to 6 DIV, using the AMPL/DIV switch and vernier control.
- Set the MAIN TIME/DIV switch and the LEVEL control to such a position that several complete cycles are displayed.
- Set the INTENS control for normal brightness.
- Adjust trimming potentiometer R19 to optimal focusing in vertical direction. R19 can be reached via one of the ventilation holes in the left side of the instrument. Put R17 90° from the anti-clockwise stop and adjust R2024 for a good horizontal focusing. The focusing in horizontal direction is now adjustable by means of R17 on the front panel of the instrument.
- Increase the trace brightness by means of the INTENS control.
- Check if the trace stays well focused. If not readjust R19 somewhat.
- Remove the input signal.
- Adjust R2102 on the storage amplifier (unit 25) to maximum equality of the trace in horizontal direction.

8.3.3.2. Trace rotation

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X-deflection controls (S2)
- Centre the time-base line using the POSITION controls
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines; if necessary, readjust the TRACE ROT control R15. This control can be reached via one of the ventilation holes on the left side of the instrument.

8.3.3.3. Orthogonality (unit 26)

- Depress push-button ALT of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button 0 of the channel A signal-coupling controls
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TB switch to 5 μs
- Set the channel B AMPL switch to 5 mV/DIV and its vernier control to CAL
- Apply a sine-wave voltage of 120 mV, frequency 100 kHz, to input B
- Centre the intensified part of the trace, using the DELAY TIME control (R1)
- Centre the channel A time-base line, using the channel A POSITION potentiometer
- Check that the angle between the horizontal and vertical line is 90°, see Fig. 8.1. If necessary, readjust **R1737** on the **X-amplifier unit.**

8.3.3.4. Geometry (= barrel and pin cushion distortion)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)

- Apply a sine-wave voltage at a frequency of approx. 100 kHz to input A
- Set the AMPL controls to obtain a trace height of 7,4 DIV
- Apply a sine-wave voltage at a frequency of approx. 50 Hz to input B
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button B of the main time-base trigger-source controls (S22)
- Set the channel B AMPL switch and X AMPL control to obtain a display width of 9,4 DIV.
- Check that the edges of the display lie within the hatched area shown in Fig. 8.2.; if necessary, readjust potentiometer **R2103** on the **X-amplifier unit.**
- Remove the input signal.

8.3.3.5. Intensity (unit 11)

- Depress push-button A of the display-mode controls
- Depress push-button DEL'D TB of the X deflection controls
- Turn the INTENS potentiometer clockwise
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 1 µs
- Depress push-button 0 of the signal-coupling controls
- Depress push-button MAIN TB of the delayed time-base trigger-source controls
- Check that there is a barely visible dot at the beginning of the trace. If necessary, readjust potentiometer **R2064** on the **Z amplifier unit.**

8.3.3.6. Intensity ratio (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Turn the DELAY TIME control (R1) to 5.0 (mid-position)
- Set the MAIN TIME/DIV switch to .2 ms and the DEL'D TIME/DIV switch to 50 µs
- Depress push-button AC of the channel A signal-coupling controls
- Apply a sine-wave signal at a frequency of 100 kHz to input A
- Set the display-height to 6 DIV
- Set the INTENS potentiometer to a position 90° from the anti clockwise stop; see Fig. 8.3.
- Check that the trace of the main time-base generator is barely visible over the entire screen and that the part determined by the delayed time-base generator is more brilliant. If necessary, readjust potentiometer **R1537** on the **time-base unit**

8.3.4. Balance adjustments

The adjustments of the vertical channels A and B are identical.
The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.
The balance adjustments influence one another and must, therefore, be readjusted in the order in which they are described.

8.3.4.1. 0-DC Balance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the channel A (B) AMPL switch to 5 mV/DIV and the vernier control to CAL.
- Centre the time-base line, using the POSITION potentiometers
- Set the channel A (B) signal coupling switch from 0 to DC
- Check that the trace does not jump; if necessary, readjust potentiometer R124 (Ch. A) or R174 (Ch. B) on the **attenuator board.**

8.3.4.2. Attenuator balance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the switches of the channel A (B) signal-coupling controls to 0
- Centre the time-base line, using the POSITION controls
- Turn the AMPL switch between 5 V/DIV and 10 mV/DIV
- Check that the trace does not jump more than 0,1 DIV; if necessary, readjust potentiometer R129 (Ch. A) or R179 (Ch. B) on the **attenuator board.**

8.3.4.3. Continue balance (Unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the switches of the channel A (B) signal-coupling controls to 0
- Rotate the channel A (B) AMPL vernier control between minimum and maximum
- Check that the trace does not move more than 1 DIV in the 2 mV/DIV position, 0,4 DIV in the 5 mV/DIV position and 0,2 DIV in the other attenuator positions; if necessary, readjust potentiometer **R211 (R311)** on the **intermediate amplifier board.**

8.3.4.4. Balance 5 mV/div (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
  Set the switches of the channel A (B) signal-coupling controls to 0
- Centre the time-base line, using the POSITION controls
- Check that the trace does not move more than 1 DIV when the AMPL switch is turned from 5 mV/DIV to 2mV/DIV and not more than 0,2DIV in the other positions and when the Ampl./DIV. is turned from 5mV/DIV to 10mV/DIV, minimum trace jumps; if necessary readjust potentiometer **R216 (R316)** on the **intermediate amplifier board.**

8.3.4.5. Polarity (Norm/Invert) balance (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the switches of the channel A (B) signal-coupling controls to 0
- Centre the time-base line, using the POSITION controls
- Set the channel A (B) AMPL switch to 10 mV/DIV
- Check that the time-base line does not shift more than 0,3 DIV when the channel A (B) POSITION control is pulled to INVERT; if necessary, readjust potentiometer **R259 (R359)** on the intermediate amplifier board.
- Set the channel A (B) AMPL switch to 2 mV/DIV
- Check that the time-base line does not shift more than 2 DIV, see also section 1.2.2.13., when the channel A (B) POSITION control is pulled to INVERT; if necessary, readjust potentiometer **R259 (R359)** on the **intermediate amplifier board.**

8.3.4.6. Trigger balance main time-base (unit 16, unit 12, unit 9)

- Depress push-button **A** of the m.t.b. trigger-source controls (S22)
- Depress push-button **A** of the display-mode controls (S1)
- Depress push-button **DC** of the m.t.b. trigger-coupling controls (S20)
- Depress push-button **AUTO** of the trigger-mode controls (S8)
- Set the m.t.b. **LEVEL** potentiometer in its mid position
- Set the **MAIN TIME/DIV.** switch to 1 msec. and its vernier to **CAL.**
- Set the **DEL'D TIME/DIV.** switch to **OFF**
- Set the potentiometer **R** 431 in its mid position
- Set the switch of the channel **A** signal coupling control to **AC**
- Apply a sine-wave signal, frequency 1 kHz to input **A**, amplitude on the screen must be 1 div.
- Adjust **R** 845 on the trigger amplifier for a triggered display
- Check that the starting point of the signal does not move when the **SLOPE** switch is set from + to –; if necessary, readjust potentiometer R 881 on the trigger-amplifier
- Depress push-button **TRIG** of the trigger-mode controls (S8)
- Depress push-button **H.F.** of the m.t.b. trigger-coupling controls (S20)
- Set the switch of the channel **A** signal coupling control to **O** (S17)
- Remove stocko-connector from socket 4 of the trigger amplifier.
- Set R 845 fully clockwise and adjust R 845 anti-clockwise untill the time-base line writes 1x.
- Depress push-button **TRIG VIEW** of the display-mode controls (S1)
- Depress push-button **AUTO** of the trigger-mode controls (S8)
- Re insert stocko-connector in socket 4 of the trigger amplifier.
- Centre the trigger view line with the m.t.b. **LEVEL** potentiometer
- Depress push-button **DC** of the m.t.b. trigger-coupling controls (S20)
- Check that the trigger-view line remains in the screen centre; if necessary, readjust potentiometer R 431 on the intermediate amplifier board.
- Depress push-button **B** of the m.t.b. trigger-source controls (S22)
- Check that the trigger-view line remains in the screen centre; if necessary, readjust potentiometer R 481 on the intermediate amplifier board.
- Depress push-button **EXT** of the m.t.b. trigger-source controls (S22)
- Check that the trigger-view line remains in the screen centre; if necessary, readjust potentiometer R 729 on the trigger source board.
- Depress push-button **A** of the display-mode controls (S1)
- Depress push-button **A** of the m.t.b. trigger-source controls (S22)
- Set the switch of the channel **A** signal coupling control to **AC**
- Centre the time-base line using the channel **A** position control.
- Apply a sine-wave signal with a frequency of 1kHz to input **A**, amplitude on the screen must be 1 div.
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the m.t.b. **LEVEL** control.
- Depress push-button **TRIG VIEW** of the display-mode control (S1)
- Shift the starting point of the sine-wave to the central horizontal graticule line readjust potentiometer R 527 on the intermediate amplifier board.
- Remove the input signal.
- Set the **MAIN TIME/DIV.** switch to.1 msec. and its vernier to **CAL.**
- Set the starting point of the m.t.b. line to the first vertical graticule line, using the **X**-position potentiometer
- Depress push-button **EXT** of the **X** deflection controls (S2)
- Depress push-button **A** of the m.t.b. trigger-source controls (S22)
- Shift the point to the central vertical graticule line,selecting resistor R1523 on the time-base (Unit8)
- Depress push-button **EXT** of the m.t.b. trigger-source control (S22)
- Shift the point to the first vertical graticule line, selecting resistor **R** 737 on the trigger-source board.

8.3.4.7. Trigger balance delayed time-base (unit 12, unit 9)

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the MAIN TIME/DIV switch to .5 μs and its vernier to CAL
- Set the DEL'D TIME/DIV switch to .2 μs and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120 mV, frequency 1 MHz, to input A
- Set the d.t.b. LEVEL potentiometer in its mid position.
- Adjust R1238 on the trigger amplifier p.c. board for a triggered display.
- Centre the display, using the channel A POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL potentiometer.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer **R428** on the intermediate amplifier board.
- Depress push-button B of the display-mode controls (S1)
- Set the channel B AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button B of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120 mV, frequency 1 MHz, to input B
- Centre the display, using the channel B POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL control.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer **R478** on the **intermediate amplifier board**
- Remove the input signal.

8.3.4.8. Y Position correction and ADD balance adjustment. (Unit 12 and 13)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X-deflection controls (S2)
- Set the vertical POSITION potentiometer to its mid-position
- Short-circuit the input of the delay-line on the intermediate amplifier board (Unit 12)
- Check that the time-base line is displayed exactly in the centre of the screen; if necessary, readjust potentiometer R658 on the final Y-amplifier board.
- Remove the short-circuit on the intermediate amplifier board
- Depress push-button ALT of the display-mode controls (S1)
- Shift the A and B traces in opposite direction, by means of the POSITION controls.
- Depress push-button ADD of the display-mode controls (S1)
- Readjust potentiometer R500 on the intermediate amplifier so that the trace appears in the centre of the screen.
- Depress push-button ALT of the display-mode controls (S1)
- Shift both traces to the centre of the screen with the POSITION controls
- Depress push-button ADD of the display-mode controls (S1)
- Readjust potentiometer R500 for minimum trace jump
  If necessary, repeat this procedure

8.3.4.9. TB MAGN balance (unit 8)

- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button A of the display-mode controls (S1)
- Move the starting point of the time-base line to the centre of the screen, using the X POSITION control
- Check that the starting point does not move when the TB MAGN control is operated; if necessary, readjust potentiometer **R1749** on the **final X amplifier (unit 26).**

8.3.5. Time-base generators

8.3.5.1. Main time-base time coefficients (unit8, unit 26)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Set the d.t.b. TIME/DIV switch to OFF and its vernier to CAL
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the channel A AMPL switch to .1 V/DIV and its vernier to CAL
- Set the switch of the channel A signal-coupling control to DC
- Apply a time-marker signal of 600 mV, pulse repetition rate 1 ms, to the channel A input
- Push the TB MAGN switch to x1
- Set the m.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Adjust the m.t.b. LEVEL potentiometer for a stable display.
- Check that the pilot lamps x10 and time-base UNCAL are off
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1709** on the final X amplifier (unit 26).
- Set the m.t.b. TIME/DIV switch to 5 ms
- Change the repetition rate of the input signal to 5 ms
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R913** on the time-base board
- Set the m.t.b. TIME/DIV switch to 1 μs
- Change the repetition rate of the input signal to 1 μs.
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R911** on the time-base board.
- Pull the TB MAGN switch to x10
- Check that the x10 pilot lamp lights up
- Change the repetition rate of the input voltage to .1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1706** on the time-base board
- Push the TB MAGN switch to x1
- Set the m.t.b. TIME/DIV switch to .1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust trimmer capacitor **C916** on the time-base board
- Check that the other positions of the m.t.b. TIME/DIV switch, using the appropriate input signals; tolerance ± 2 % at an ambient temperature of 20 to +30 °C.
- Check that the control range of the m.t.b. TIME/DIV vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of its CAL position.
- Put the m.t.b. TIME/DIV control in the 0,05μs/DIV position and pull the TB MAGN switch in the X10 position.
- Apply a time marker signal with a repetition rate of 10ns to the channel A input.
- Adjust trimming capacitor C1703 on the final X amplifier (unit 26) so that the four time marker pulses in the horizontal centre 8 divisions coincide with the graticule.

8.3.5 2. Delayed time-base time coefficients (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Rotate the DELAY TIME control (R1) fully anti-clockwise (minimum delay time)
- Push the TB MAGN switch to x1
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Check that the time-base UNCAL lamp is off
- Apply a time-marker signal of 600 mV, repetition rate 1 ms, to the channel A input
- Set the channel A AMPL switch to .1 V/DIV and its vernier to CAL

- Adjust the d.t.b. LEVEL control for a stationnary display
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1326** on the time-base board
- Set the m.t.b. TIME/DIV switch to 10 ms
- Set the d.t.b. TIME/DIV switch to 5 ms
- Change the repetition rate of the input signal to 5 ms
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1318** on the time-base board
- Set the m.t.b. TIME/DIV switch to 2 μs
- Set the d.t.b. TIME/DIV switch to 1 μs
- Change the repetition rate of the input signal to 1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1321** on the time-base board
- Set the m.t.b. TIME/DIV switch to .2 μs
- Set the d.t.b. TIME/DIV switch to .1 μs
- Change the repetition rate of the input signal to .1 μs
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust trimmer capacitor **C1311** on the time-base board
- Check the sweep times in all other positions of the d.t.b. TIME/DIV switch; tolerance ± 2% in temperature range +20 ... +30 °C. Keep during this check the DELAY TIME control fully anti-clockwise and the m.t.b. TIME/DIV switch one position slower than the d.t.b. TIME/DIV switch.
- Check that the control range of the d.t.b. TIME/DIV vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of its CAL position.

8.3.5.3. Delay time (unit 9)

- Depress push-button A of the display-mode controls (S1)
- Set the switch of the channel A signal-coupling control to DC
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the d.t.b. trigger-source controls (S21)
- Push the TB MAGN switch to position x1
- Set the AMPL./DIV of channel A to .1V/DIV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to .1 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to .05 μs and its vernier to CAL
- Set the DELAY TIME control (R1) to 1.00
- Apply a time marker voltage with a repetition rate of .1 ms to the channel A input
- Check that the intensified spot on the trace coincides with the starting point of the second time marker pulse; if necessary, readjust potentiometer **R1384** on the trigger amplifier board
- Set the DELAY TIME control (R1) to 9.00
- Check that the intensified spot on the trace coincides with the starting point of the tenth time marker pulse; if necessary, readjust potentiometer **R1379** on the **trigger amplifier board**
- Remove the input signal.

As both adjustments are slightly interdependent, they must be repeated until both conditions are fulfilled.

8.3.5.4. Alternate time-base and trace separation

- Depress push-button A of the display-mode controls (S1)
- Depress push-button ALT TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .5 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to .05 μs and its vernier to CAL
- Set the switch of the channel A signal-coupling control to 0
- Check that the distance between the two traces is 0 DIV with the TRACE SEP control turned anti-clockwise and approximately 4 DIV with this control turned clockwise.

8.3.6. L.F. correction and sensitivities

Before checking the sensitivities, check the balances in accordance with section 8.3.4. Balance adjustments.

8.3.6.1. L.F. correction amplifier (attenuator unit)

- Depress push-button A (B) of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A (B) signal coupling controls to DC
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the channel A (B) AMPL switch to 10mV/DIV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to .5ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60mV, repetition rate 200Hz, to the channel A (B) input
- Check that the pulse top is straight; if not adjust potentiometer R132 (R182) on **the attenuator unit (unit 2).**

8.3.6.2. L.F. correction MTB external input (unit 16)

- Depress push-button TRIG VIEW of the display mode selector S1
- Depress push-button MAIN TB of the horizontal deflection selector S2
- Depress push-button EXT of the MTB trigger source selector S22
- Depress push-button DC of the MTB trigger coupling switch S20
- Set MTB TIME/DIV switch in the 0,1 ms/DIV. position
- Set the DTB TIME/DIV switch in the OFF position
- Apply a 2kHz/600mV square-wave signal to the MTB external input socket X7
- Position the wave form on the screen by means of the MTB level control R7
- Check that the pulse top is straight; if not adjust pot. meter R736 on the trigger source unit (unit 16)
- Remove the input signal

8.3.6.3. L.F. correction DTB external input (unit 16)

- Depress push-button TRIG VIEW of the display mode selector S1
- Depress push-button MAIN TB of the horizontal deflection selector S2
- Depress push-button EXT of the DTB trigger source selector S21
- Depress push-button DC of the DTB trigger coupling switch S19
- Set the MTB TIME/DIV switch in the 0,1 ms/DIV position
- Set the DTB TIME/DIV switch in the OFF position
- Switch the instrument off and change on unit 9 the coax cables for the MTB and DTB trigger signals from unit 16
- Switch the instrument on again
- Apply a 2kHz/600mV square wave signal to the DTB external input socket X6
- Position the waveform on the screen by means of the MTB level control R7
- Check if the pulse top is straight; if not adjust R1118 on the trigger source unit (unit 16)
- Switch the instrument off and change the coax cables for the MTB and DTB trigger signals again
- Switch the instrument on again
- Remove the input signal

8.3.6.4. Gain (sensitivity) Y_A VIA Y (unit 13)

- Set front panel GAIN potentiometer R12 in its mid position
- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A signal-coupling control to AC
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV to 0,2ms/DIV
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Check that the trace-height is 6 DIV; if necessary, readjust potentiometer **R654** on the **final Y amplifier board.**
- Check that the control range of the channel A AMPL vernier control is 1 : 2,6 to 1 : 3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of the CAL position

8.3.6.5. *Gain (sensitivity) Y_B VIA Y*

- Depress push-button B of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel B signal-coupling control to AC
- Depress push-button B of the m.t.b. trigger-source controls
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Check that the trace height is 6 DIV; if necessary, readjust GAIN potentiometer R13 on the front panel
- Check that the control range of the channel B AMPL vernier control is 1 : 2,6 to 1 : 3,5 and the pilot lamp UNCAL light up as soon as the vernier is out of the CAL position
- Remove the input signal

8.3.6.6. *Gain (sensitivity) at external X deflection (unit 16)*

- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Set the X AMPL-HOLD OFF control to CAL
- Apply a 300mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Adjust the X POSITION potentiometer R2 so that there are two points displayed on the screen
- Check that the trace width is 6 DIV; if necessary, readjust potentiometer R742 on the trigger-source board
- Check that the control range of the X AMPL-HOLD OFF control is 1 : 2,6 to 1 : 3,5
- Set the X AMPL-HOLD OFF control to CAL
- Depress push-button EXT ÷ 10 (S22) of the m.t.b. trigger source controls
- Increase the amplitude of the input signal by a factor of 10
- Check that the trace width is 6 DIV ± 2 SUBDIV
- Remove the input signal

8.3.6.7. *Gain (sensitivity) external triggering via TRIG VIEW (unit 9)*

- Depress push-button TRIG VIEW of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV. switch to 0,2m sec.
- Position the waveform in the middle of the screen by means of the m.t.b. LEVEL potentiometer.
- Apply a 600mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV; if necessary, readjust potentiometer **R842** on the **trigger amplifier board.**
- Remove the input signal

8.3.6.8. *Gain (sensitivity) Y_A TRIG VIEW (unit 12)*

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Depress push-button A (S22) of the m.t.b. trigger-source controls
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Set the channel A and B POSITION controls fully anticlockwise
- Centre the trigger - view waveform by means of the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV; if necessary readjust potentiometer **R413** on the intermediate amplifier board

8.3.6.9. *Gain (sensitivity) Y_B TRIG VIEW (unit 12)*

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel B AMPL switch to 0.5V/DIV and its vernier to CAL
- Depress push-button B (S22) of the m.t.b. trigger-source controls
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Centre the display, using the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV; if necessary readjust potentiometer **R463** on the intermediate amplifier board

8.3.6.10. *Gain (sensitivity) Y_A VIA X*

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A signal-coupling control to AC
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Adjust the X POSITION potentiometer R2 so that there are two points displayed on the screen
- Position these two points on the middle of the screen by means of the channel B POSITION control
- Check that the trace width is 6 DIV ± 0,3 DIV

8.3.6.11. *Gain (sensitivity) Y_B VIA X*

- Depress push-button A of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel B signal-coupling control to AC
- Depress push-button B of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Adjust the X POSITION potentiometer R2 so that there are two points displayed on the screen.
- Position these two points on the middle of the screen by means of the channel A POSITION control
- Check that the trace width is 6 DIV ± 0,3 DIV.
- Remove the input signal.

8.3.7. Vertical channels

The adjustments of the vertical channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A. Before performing the following tests, the balances and sensitivities must be checked in accordance with sections 8.3.4. and 8.3.6.

8.3.7.1. Square-wave response (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set the switches of the channel A (B) signal-coupling controls to DC
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .1ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage with a frequency of 2kHz rise time ≤ 200 ns, to the channel A (B) input; peak to peak value as indicated in the table below
- Check that the pulse top errors do not exceed +/–3%; if necessary, readjust the relevant trimmers

A (B) AMPL	Y_A (Y_B) input signal	Adjuster	Trace height
2 mV	12 mV	–	6 DIV +/–3 %
5 mV	30 mV	–	6 DIV +/–3 %
10 mV	60 mV	–	6 DIV +/–3 %
20 mV	120 mV	–	6 DIV +/–3 %
50 mV	300 mV	–	6 DIV +/–3 %
.1 V	600 mV	C107 (ch. A) or C157 (ch. B)	6 DIV +/–3 %
.2 V	1,2 V	–	6 DIV +/–3 %
.5 V	3 V	–	6 DIV +/–3 %
1 V	6 V	C112 (ch. A) or C162 (ch. B)	6 DIV +/–3 %
2 V	12 V	–	6 DIV +/–3 %
5 V	30 V	–	6 DIV +/–3 %

- Remove the input signal.

8.3.7.2. Input capacitance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set the switches of the channel A (B) signal-coupling controls to DC
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .1ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage with a frequency of 2 kHz, rise time ≤200 ns, to the channel A (B) input via an 2:1 dummy probe, Fig. 8.4..
  (1 Mohm ± 0,1 %//15 pF); peak to peak value as indicated in the table below
- Check that the pulse top errors do not exceed +/–3 %; if necessary, readjust the relevant trimmers.

Into the dummy probe

A (B) AMPL	Y_A (Y_B) input signal	Adjuster	Trace height
2 mV	12 mV	C101 (ch. A) or C151 (ch. B)	3 DIV +/–3 %
5 mV	30 mV	–	3 DIV +/–3 %
10 mV	60 mV	–	3 DIV +/–3 %
20 mV	120 mV	–	3 DIV +/–3 %
50 mV	300 mV	–	3 DIV +/–3 %
100 mV	600 mV	C104 (ch. A) or C154 (ch. B)	3 DIV +/–3 %
.2 V	1,2 V	–	3 DIV +/–3 %
.5 V	3 V	–	3 DIV +/–3 %
1 V	6 V	C109 (ch. A) or C159 (ch. B)	3 DIV +/–3 %
2 V	12 V	–	3 DIV +/–3 %
5 V	30 V	–	3 DIV +/–3 %

– Remove the input signal.

8.3.7.3. Square-wave response final Y amplifier

– Depress push-button ALT of the display-mode controls (S1)
– Depress push-buttons A and B (COMP) of the m.t.b. trigger-source controls (S22)
– Depress push-button MTB of the X deflection controls (S2)
– Set the Y POSITION controls to obtain a distance of 6 DIV between both time-base lines (channel A time-base line at the top)
– Set the X Magnifier in the x 1 position
– Remove the main time-base connector from the alternate control pulse socket on the intermediate amplifier board, unit 12, socket 9, fig. 8.8..
– Connect a square-wave with an amplitude of 3V to socket 9 of unit 12
– Both time-base lines will be displayed at a frequency determined by the frequency of the square-wave voltage.

200 Hz (unit 13)

– Set the generator frequency to 200 Hz
– Set the m.t.b. controls to obtain a suitable, triggered display
– Check that the top of the displayed pulse in straight within 2%; if necessary, put R634 in its mid position and select C613 to such a value (≈2n7) that the square wave response is optimal.
– Adjust R634 to optimal square wave response.

2 kHz (unit 13)

– Set the generator frequency to 2 kHz
– Set the m.t.b. controls to obtain a suitable, triggered display
– Check that the top of the displayed pulse is straight within 2%; if necessary, put R636 in its mid position and select C614 to such a value (≈39pF) that the square wave response is optimal.
– Adjust R636 to optimal square wave response.
– Reconnect socket 9 (Fig. 8.8.).

8.3.7.4. Square-wave response channel A (unit 12 and 13)

– Depress push-button A of the display-mode controls (S1)
– Push the Y POSITION controls to the NORM position
– Set the switch of the channel A signal-coupling control to DC
– Set the channel A AMPL switch to 10 mV/DIV and its vernier to CAL
– Set the XMagnifier in the X1 position
– Depress push-button MTB of the Xdeflection controls (S2)
– Depress push-button A of the m.t.b. trigger-source controls (S22)
– Set the m.t.b. TIME/DIV switch to a suitable value
– Set the d.t.b. TIME/DIV switch to OFF
– Apply a square-wave voltage of 60 mV, rise time 1 ns, repetition rate 2 kHz, to the channel A input
– Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary readjust potentiometer R257 or select a different value for capacitor C229 (≈4n7) on the intermediate Y amplifier adjusting board
– Increase the repetition rate of the input signal to 30 kHz
– Put the instrument in the Magnifier X10 mode for better waveform analysis

- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust potentiometers R253 and R254 or select a different value for capacitors C227 (≈33pF) and C228 (≈1n) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse is straight within 2% and that the rise time is as short as possible, if necessary, select capacitor C224 (≈27p) and readjust potentiometer R244 for an optimal result
- Select C233 on the intermediate amplifier (unit 12) to such a value (between 2p2 and 6p8) that the square wave response is optimal
- Set the generator frequency to 30 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2%; if necessary, readjust trimmer 616 on the Y-amplifier board (unit 13)
- Set the generator frequency to 100 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2%; if necessary, readjust potentiometer R646 on the final Y amplifier board
- Put the channel A VOLTS/DIV control in the position 5mV/DIV. and its vernier to CAL.
- Apply a square-wave voltage of 30mV, rise-time 1ns, repetition rate 100kHz, to the channel A input.
- Check that the pulse top is straight within 2% and that the rise-time is as short as possible: if necessary readjust trimming capacitor C215 on the intermediate amplifier (unit 12).
- Check the square-wave response in positions 5 mV/DIV and 2 mV/DIV of the AMPL switch at input voltages of 30 mV and 12 mV. The pulse top aberrations must not exceed 2%
- Pull the channel A Y POSITION control to INVERT
- Repeat the checks described above; the response must be the same and the pulse top aberrations must remain within 2%
- Depress push-button B of the display-mode controls (S1)
- Set the switch of the channel B signal-coupling control to 0
- Set the channel B time-base line in the middle of the screen with the POSITION control (R4)
- Depress push-button A of the display-mode controls (S1)
- Set the switch of the channel A signal-coupling control to 0
- Set the channel A time-base line in the middle of the screen with the POSITION control (R3)
- Set the switch of the channel A signal-coupling control to DC
- Depress push-button ADD of the display-mode controls and check that the response does not change
- Check that the pulse top aberrations remain within ± 2%
- Remove the input signal

8.3.7.5. *Square-wave response channel B (unit 12)*

- Depress push-button B of the display-mode controls (S1)
- Push the channel A POSITION control to NORM position
- Set the switch of the channel B signal-coupling control to DC
- Set the channel B AMPL switch to 10 m V/DIV and its vernier to CAL
- Set the XMagnifier in the X1 position
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button B of the m.t.b. trigger source-controls (22)
- Set the m.t.b. TIME/DIV switch to a suitable value
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, rise time 1 ns, repetition rate 2 kHz, to channel B input
- Check that the pulse top is straight within 2% and the rise time is as short as possible; if necessary readjust potentiometer R357 or select a different value for capacitor C329 (≈4n7) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 30 kHz
- Put the instrument in the Magn X10 mode for better waveform analysis
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust potentiometers R353 and R354 or select a different value for capacitors C327 (≈33pF) and C328 (≈1n) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, select capacitor C324 (≈27p) and readjust potentiometer R344 for an optimal result
- Select C333 on the intermediate amplifier (unit 12) to such a value (between 2p2 and 6p8) that the square wave response is optimal

- Put the channel B VOLTS/DIV control in the position 5mV/DIV. and its vernier to CAL.
- Apply a square-wave voltage of 30mV, rise-time 1ns, repetition rate 100kHz, to the channel B input.
- Check that the pulse top is straight within 2% and that the rise-time is as short as possible: if necessary readjust trimming capacitor C315 on the intermediate amplifier (unit 12).
- Check the square-wave response in position 5 mV/DIV and 2 mV/DIV of the AMPL switch at input voltages of 30 mV and 12 mV. The pulse top aberrations must not exceed 2%
- Pull the channel B POSITION control to INVERT
- Repeat the checks described above; the response must be the same and the pulse top aberrations must remain within 2%
- Depress push-button A of the display-mode control (S1)
- Set the switch of the channel A signal-coupling control to 0
- Set the channel A time-base line in the middle of the screen with the POSITION control (R3)
- Depress push-button B of the display-mode controls (S1)
- Set the switch of the channel B signal-coupling control to 0
- ~~Set the channel B time-base line in the middle of the screen with the POSITION control (R4)~~
- Set the switch of the channel B signal-coupling control to DC
- Depress push-button ADD of the display-mode and check that the response does not change
- Check that the pulse top aberrations remain within ± 2%
- Remove the input signal

8.3.7.6. *Bandwidth*

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to the NORM position
- Set the channel A (B) AMPL switch to 2 mV/DIV and its vernier to CAL
- Set the switch of the signal coupling control to AC
- Depress push-button MTB of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button HF of the trigger-coupling controls
- Depress push-button A (B) of the trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to 2μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 16 mV_{p-p}, frequency 2 MHz , to the channel A (B) input
- Check that the trace height is 8 DIV
- Increase the frequency of the input signal to 35 MHz
- Check that the trace height is at least 5,6 DIV
- Set the channel A (B) AMPL switch to 5 mV/DIV and its vernier to CAL
- Increase the input voltage to 40 mV_{p-p}, frequency 2 MHz
- Check that the trace height is 8 DIV
- Increase the frequency of the input voltage to 100 MHz
- Check that the trace height is at least 5,6 DIV
- Remove the input signal

8.3.7.7. *Common-mode rejection*

- Depress push-button A of the display-mode controls (S1)
- Set the channel A time-base line in the middle of the screen with the POSITION control (R3)
- Depress push-button B of the display-mode controls (S1)
- Set the channel B time-base line in the middle of the screen with the POSITION control (R4)
- Set the channel A and B signal-coupling switches to DC
- Push the channel A POSITION control to NORM
- Pull the channel B POSITION control to INVERT
- Set both AMPL controls to 10mV/DIV and their verniers to CAL
- Apply a sine-wave voltage of 240mV_{p-p} simultaneously to the channel A and B inputs
- Depress push-button ADD of the display-mode controls (S1)
- Check the rejection in accordance with the following table
- Set the m.t.b. TIME/DIV. switch to a suitable value.

Note: Adjust the channel A or B AMPL vernier control for minimum trace height.

Input voltage	Frequency	Max. trace height	Rejection factor
240 mV	100 kHz	1,2 SUBDIV	>100
240 mV	2 MHz	1,2 SUBDIV	> 100
240 mV	50 MHz	6 SUBDIV	> 20

- Push the channel B POSITION control to NORM
- Remove the input signal.

8.3.7.8. *Dynamic range and position range*

- Depress push-button A (B)of the display-mode controls (S1)
- Set both AMPL switches to 5mV/DIV and their verniers to CAL
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave signal of 120 mV_{p-p}, frequency 10 kHz, to the channel A (B) input
- Check that the top and bottom parts of the sine-wave signal can be displayed, reasonably undistorted, within the measuring graticule, using the channel A (B) POSITON control
- Remove the input signal.

8.3.7.9. *Chopped mode*

- Depress push-button CHOP of the display-mode controls
- Set the m.t.b. TIME/DIV switch to .2 µs
- Check that there are two time-base lines displayed which can be shifted in relation to each other, using the Y POSITION controls (R3 and R4)

8.3.7.10. *Alternate mode*

- Depress push-button ALT of the display-mode controls
- Set the m.t.b. TIME/DIV switch to 10 µs
- Check that there are two time-base lines displayed which can be shifted in relation to each other, using the Y POSITION controls (R3 and R4)
- Set the m.t.b. TIME/DIV switch to .1 s
- Check that the channels are switched over after every sweep of the time-base voltage.

8.3.7.11. *Square-wave response trigger view via EXT*

- Depress push-button **TRIG VIEW** of the display-mode controls
- Depress push-button **DC** of the m.t.b.-coupling controls
- Depress push-button **EXT** of the trigger-source controls
- Depress push-button **MAIN TB** of the **X** deflection controls
- Push the **Y POSITION** controls to the **NORM** position
- Set the m.t.b. **TIME/DIV** switch to a suitable position
- Set the d.t.b. **TIME/DIV** switch to **OFF**
- Apply a square-wave voltage of 600mV p.p., frequency 100 kHz, risetime 1 nsec. to the m.t.b. **EXT** input
- Check that the pulse top is straight and that the risetime is as short as possible; if necessary, select capacitor C819(≈22p) on the trigger amplifier P.C. board and capacitor C714(≈1,8p) on the trigger source P.C. board
- Remove the input signal

8.3.7.12. *Square-wave response trigger view via channel A (B) (Unit 12)*

- Depress push-button TRIG VIEW of the display-mode controls
- Push the Y POSITION controls to the NORM position
- Set the switches of the channel A and B signal-coupling controls to DC
- Set both AMPL switches to 10 mV/DIV and their verniers to CAL
- Depress push-button MTB of the X deflection controls
- Depress push-button A (B) of the m.t.b. trigger-source controls
- Set the m.t.b. TIME/DIV switch to a suitable position
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, frequency 2 kHz, rise time 1 ns, to the channel A (B) input
- Depress push-button DC of the m.t.b. signal-coupling control (S20)
- Check that the pulse top of the trigger view signal is straight and the rise-time as short as possible
- Increase the repetition rate of the input signal to 30kHz
- Check that the pulse top is straight within 5% and that the rise-time is as short as possible, if necessary, readjust potentiometers R409 (R459) and select a different value of the capacitors C404(C454) (≈2,7n) and C407 (C457) (≈270p) on the intermediate board.
- Increase the repetition rate of the input signal to 100kHz
- Check that the pulse top is straight within 5% and that the rise time is as short as possible; if necessary, readjust potentiometer R411 (R461) select a different value of the capacitor C408 (C458) (≈82p) and readjust potentiometer R416 (R466) and select a different value of the capacitor C411 (C461) (≈39p) on the intermediate amplifier board
- Remove the input signal

8.3.7.13. Bandwidth trigger view via channel A (B)

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Push the Y POSITION controls to NORM position
- Set both AMPL switches to 10 mV/DIV and their verniers to CAL
- Set the switches of the signal-coupling controls to AC
- Depress push-button MTB of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button HF of the m.t.b. trigger-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 60 mV_{p-p}, frequency 2 MHz, to the channel A (B) input
- Centre the trigger-view signal by means of the m.t.b. LEVEL control
- Check that the trace height of the trigger view signal is 6 DIV
- Increase the frequency of the input voltage to 80MHz
- Check that the trace height is at least 4,2 DIV
- Remove the input signal

8.3.7.14. Bandwidth trigger view via external input

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 600 mV_{p-p}, frequency 2 MHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV
- Increase the frequency of the input signal to 80MHz
- Check that the trace height is at least 4,2 DIV
- Remove the input signal.

8.3.8. Triggering

8.3.8.1. Trigger slope and level of the m.t.b. (unit 9)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the switch of the channel A input-coupling control to DC
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20 mV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 10 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 120 mV_{p-p}, frequency 30 kHz, to the channel A input
- Centre the display, using the POSITION control.
- Centre the starting point of the sine-wave, using the m.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to – if necessary readjust potentiometer R881 on the trigger amplifier (unit 9).
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going edge of the sine-wave and moves upwards when the LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to its – position
- Check that the time-base generator starts on the negative-going edge of the sine-wave.
- Set the channel A AMPL switch to 5 mV/DIV
- Rotate the m.t.b. LEVEL control fully clockwise and fully anti-clockwise
- Check that in both extreme positions the time-base generator cuts out and that the NOT TRIG'D lamp lights up, if necessary readjust R845 on unit 9.

- Increase the amplitude of the input signal to 160 mV_{p-p}
- Rotate the m.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered and that the NOT TRIG'D lamp does not light up
- Remove the input signal.

8.3.8.2. Trigger sensitivities m.t.b.

- Depress push-button MTB of the X deflection controls (S2)
- Adjust the m.t.b. LEVEL control for a stationary display
- Set the switches of the signal-coupling controls to DC
- Set the m.t.b. TIME/DIV switch to such a position that a reasonable number of sine waves is written on the screen
- Set the d.t.b. TIME/DIV switch to OFF
- Check the trigger sensitivity in accordance with the table below

Input	Frequency sine wave	Display mode	Trigger mode	Trigger coupling MTB	Trigger source MTB	Trace height/ Volts
A	20 Hz	A	AUTO	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	AUTO	DC	A	0,5 DIV up to 1,5 DIV
A	20 Hz	A	TRIG	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	TRIG	DC	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	TRIG	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	TRIG	HF	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	TRIG	HF	A	0,5 DIV up to 1,5 DIV
B	20 Hz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
B	20 kHz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
B	100 MHz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
A and EXT	20 Hz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and EXT	20 kHz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and EXT	100 MHz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and B	20 kHz	ALT	TRIG	DC	A+B	50 mV up to 150mV
A and B	30MHz	ALT	TRIG	HF	A+B	50 mV up to 150mV

- Remove the input signal

8.3.8.3. Single-sweep operation

- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to .2 V/DIV and its vernier to CAL
- Depress push-button MTB of the X deflection controls (S2)
- Set the m.t.b. LEVEL control to mid-range
- Set the m.t.b. TIME/DIV switch to .1 s and the vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button AUTO of the m.t.b. trigger-mode control (S8)
- Apply a sine-wave signal of 5Hz to the channel A input
- Adjust the trace-height to approximately 6 DIV
- Set the switch of the channel A signal-coupling control to 0
- Push the SINGLE button of the m.t.b. trigger-mode controls (S8)
- Check that the NOT TRIG'D lamp lights up
- Set the switch of the channel A signal-coupling control to AC
- Check that the trace is written once and that the NOT TRIG'D lamp is extinghuished at the end of the sweep
- Remove the input signal.

8.3.8.4. Triggering at mains frequency

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button DC of the trigger-coupling controls
- Set the m.t.b. TIME/DIV switch to 5 ms and its vernier to CAL
- Depress push-button EXT of the trigger-source controls (S22)
- Apply a mains voltage derived signal to the channel A input
- Adjust the trace height to approx. 3 DIV; the trace must be running
- Depress push-button EXT and EXT ÷ 10 (S22) simultaneously (LINE)
- Check that a stable display can be obtained, using the m.t.b. LEVEL control
- Remove the input signal.

8.3.8.5. Trigger slope and level of the d.t.b.

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20 mV/DIV and its vernier to CAL
- Turn the DELAY TIME (R1) control fully anti-clockwise
- Set the m.t.b. TIME/DIV switch to 20 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to 10 μs and its vernier to CAL
- Apply a sine-wave voltage of 120 mV_{p-p}, frequency 30 kHz, to the channel A input
- Centre the display, using the POSITION controls
- Centre the starting point of the sine-wave, using the d.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to –
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going part of the sine-wave and moves upwards when the d.t.b. LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to – position
- Check that the time-base generator starts on the negative-going part of the sine-wave
- Set the channel A AMPL switch to 5 mV/DIV and its vernier to CAL
- Rotate the d.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the time-base generator cuts out
- Increase the amplitude of the input signal to 160 mV_{p-p}
- Rotate the d.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered.
- Remove the input signal

8.3.8.6. Trigger sensitivities d.t.b.

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Adjust the d.t.b. LEVEL control for a stationary display
- Depress push-button AUTO of the m.t.b. trigger-mode controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-buttons DC of the signal-coupling controls of the m.t.b.
- Set the m.t.b. TIME/DIV switch one position lower (longer sweep time) than the d.t.b. TIME/DIV switch
- Set the d.t.b. TIME/DIV switch to such a position that a reasonable number of sine waves is written (not for 20 Hz)
- Check the trigger sensitivity in accordance with the table below

Input	Frequency sine wave	Display mode	Trigger coupling d.t.b.	Trigger source d.t.b.	Trace height Volts
A	20 Hz	A	DC	MAIN TB	0,5 DIV up to 1,5 DIV
A	100 MHz	A	DC	MAIN TB	0,5 DIV up to 1,5 DIV
A	20 Hz	A	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	DC	A	0,5 DIV up to 1,5 DIV
A	20 Hz	A	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	HF	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	HF	A	0,5 DIV up to 1,5 DIV
B	20 Hz	B	DC	B	0,5 DIV up to 1,5 DIV
B	20 kHz	B	DC	B	0,5 DIV up to 1,5 DIV
B	100 MHz	B	DC	B	0,5 DIV up to 1,5 DIV
A and EXT dtb	20 Hz	A	DC	EXT	50 mV up to 150 mV
A and EXT dtb	20 kHz	A	DC	EXT	50 mV up to 150 mV
A and EXT dtb	100 MHz	A	DC	EXT	50 mV up to 150 mV

- Remove the input signal.

8.3.9. Jitter

- Depress push-button A of the display-mode controls (S1)
- Set the DELAY TIME (R1) control to 9.00
- Push the TB MAGN switch to position x1
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the d.t.b. TIME/DIV switch to 2 μs and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Depress push-button AUTO of trigger-mode controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the d.t.b. trigger-source controls (S21)
- Apply a square-wave voltage for a trace height of 4 DIV, repetition rate 20 μs, to the channel A input
- Adjust the m.t.b. LEVEL control for a stable, triggered display
- Check that the time jitter does not exceed 0,3 DIV
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Check that a jitter-free display can be obtained, setting the d.t.b. LEVEL control
- Remove the input signal.

8.3.10. Periodic and random deviations

These must be measured only with the cabinet plates fitted

- Inputs of channel A and B open
- Set the switches of the signal-coupling controls of channel A and B to AC
- Set both AMPL switches to 2mV/DIV and their verniers to CAL
- Depress push-button ALT of the display-mode control
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUT of the trigger-mode controls
- Measure the periodic and random deviations in accordance with the following table:

Ripple ¼ SUBDIV at maximum
Noise ¼ SUBDIV at maximum
Microphony ¼ SUBDIV at maximum
Converter interference ¼ SUBDIV at maximum
Instability of the trace ¼ SUBDIV at maximum
Parasitic Z modulation must not be visible

8.3.11. Effect of the mains voltage variations

- Depress push-button CHOP of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Pull the TB MAGN switch to x10
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button AUTO of the trigger-mode controls
- Set both AMPL switches to 0.5 V/DIV and their verniers to CAL
- Set the switches of the signal-coupling controls of channel A and B to AC
- Interconnect the CAL socket and inputs A and B
- Vary the mains voltage by + and – 10 %
- Check that neither trace height nor trace width changes and that the briliance remains the same
- Remove the input signal of channel A and B

8.3.12. Horizontal amplifier

8.3.12.1. Bandwidth

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 3 $V_{p\text{-}p}$, frequency 2 kHz, to the channel A input
- Check that the trace width is 6 DIV
- Increase the frequency of the input signal to 2 MHz
- Check that the trace width is at least 4,2 DIV
- Remove the channel A input signal

8.3.12.2. Phase difference

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set both AMPL switches to 5 mV/DIV and their verniers to CAL
- Set the switches of the signal-coupling controls of channel A and B to DC
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 30mV$_{p\text{-}p}$, frequency 100kHz, to the channel A (B) input
- Check that the phase difference does not exceed 3^{o} (see Fig. 8.5. in which $\frac{B}{A}$ equals the sine of the phase error angle.

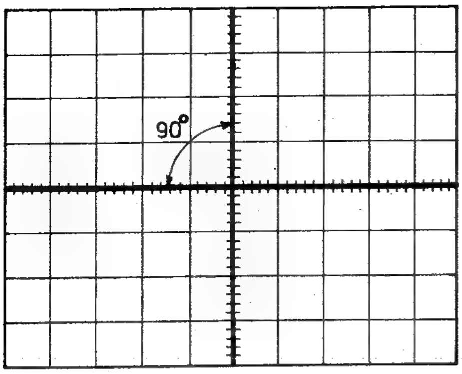


Fig. 8.1. Orthogonality check

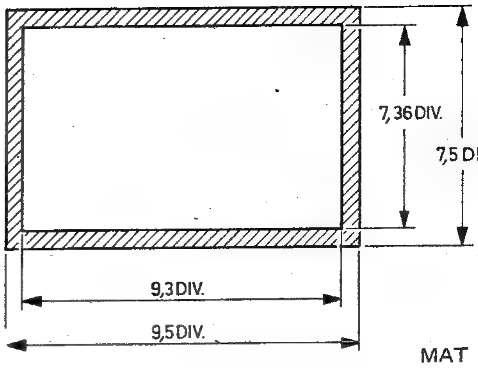


Fig. 8.2. Geometry check

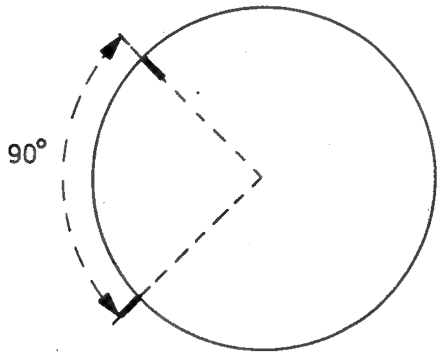


Fig. 8.3. Position of the INTENS potentiometer

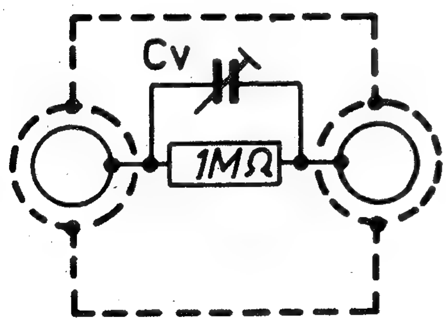


Fig. 8.4. 2:1 Dummy probe

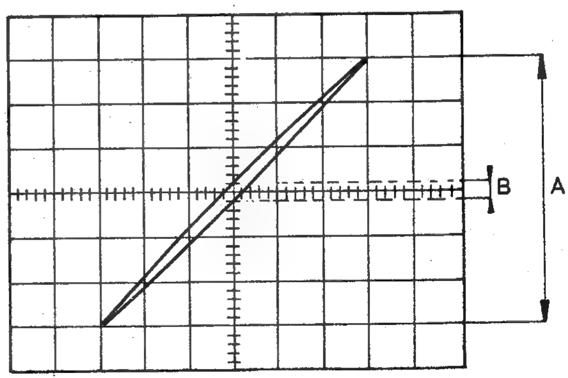


Fig. 8.5. Phase difference check in X-Y mode

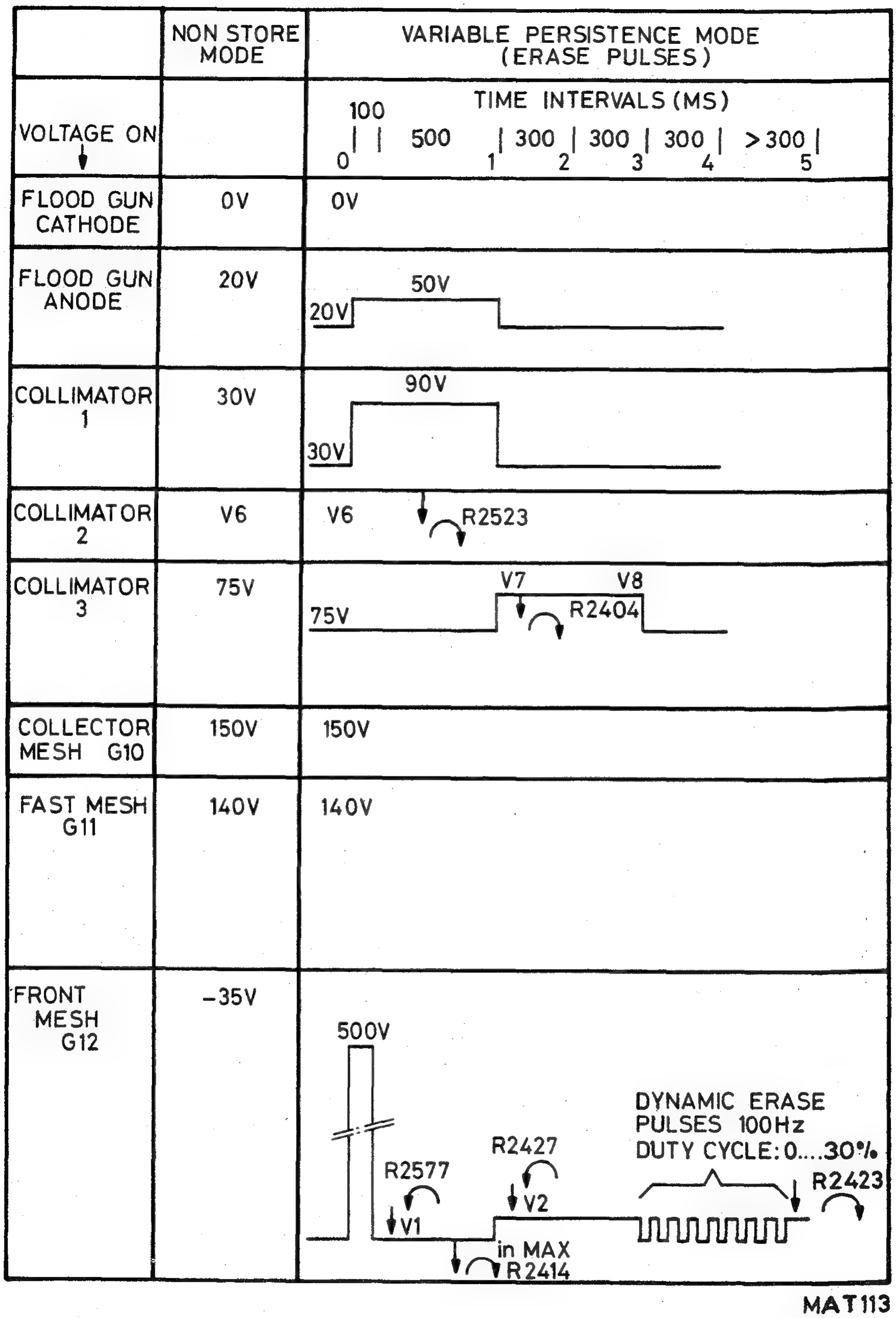


Fig. 8.6. Adjustments of the WRITE or VARIABLE PERSISTENCE mode

8.3.13. Adjustment procedure of storage section

8.3.13.1. Introduction

The voltage levels are indicated in fig. 8.6. for the WRITE or VARIABLE PERSISTENCE mode and in fig. 8.7. for the FAST mode. For the MEMORY OFF and the STORE mode there are no adjustments to be done. When measuring voltage levels on the front mesh take care that the measuring oscilloscope and probe can withstand 500 Volt pulses.

8.3.13.2. Important notes

WARNING: **Excessive intensity for a prolonged period can damage the CRT, especially in the EXT X DEFL mode when a spot is displayed on the CRT-screen.**

Burning in period for CRT

If a new CRT is installed in an instrument this tube must be burned in during 48 ... 72 hours before the adjustment procedure is started. This burning-in procedure must be done in the WRITE mode, at minimum persistence (green background) and with the INTENS control in minimum position.

Writing speed, background illumination, storage time

At certain moments in this adjustment procedure the background illumination must be adjusted. The amount of background illumination that you allow depends – within certain limits – on your personal taste. However bear the following in mind:
- A high background illumination gires a high writing speed, but a short storage time.
- A low background illumination results in a lower writing speedand a longer storage time.
- The storage time is the time between the moment that a waveform is written in and the moment that the waveform is irreadable due to the increased background illumination.

Focus is important

For optimal results it is very important to have a well adjusted focusing. This adjustment is carried out in the MEMORY OFF mode with a sine-wave signal of 6 DIV/2,5kHz on the screen at maximum intensity. The horizontal FOCUS control R17 must be in a position of 90° from its counter clockwise stop. Now the focusing in vertical direction must be adjusted with R19 in the left side panel and the horizontal focusing with R 2024 on unit 11.
Small readjustments of R19 and R 2024 may be necessary when adjusting the (MAX) WRITE and FAST modes.
Bear in mind that the FOCUS control R17 on the front panel needs a small readjustment when the instrument is switched between MEMORY OFF, (MAX) WRITE and FAST mode.

Control VARIABLE/MAX WRITING SPEED (S27).
This control is present at the rear of the instrument and during the adjustments it must occupy the MAX position. Now writing speed versus background illumination is not adjustable by means of R20.

8.3.13.3. How to check the writing speed

The adjustments that have to be done are necessary to obtain the specified writing speed at a good quality of the picture. This chapter explains how to measure the writing speed over the entire screen.

A sinewave with an amplitude of A divisions and a frequency f has a writing speed $V = 2.\pi.f.A.$ divisions per second at zero crossing; π is approx. 3.14. When a signal giving 32 divisions peak-peak deflection is applied to the vertical input; it can be regarded that the zero crossing of this signal covers the entire screen area. The time base TIME/DIV. switch must be adjusted to about ten periods of the signal on the screen.

When using the formula stated above the following values can be calculated:

- In the WRITE mode the writing speed is specified at 0,25 DIV/μs in single shot mode. When a signal is applied giving 32 divisions vertical deflection the amplitude is 16 divisions. The frequency now can be calculated: f = 2,5 kHz.
- In the MAX WRITE mode the writing speed must be 2,5 DIV/μs and therefore f = 25 kHz.
- In the FAST mode the writing speed must be 1000 DIV/μs and therefore f = 10 MHz.

8.3.13.4. Adjustment of the max. write or variable persistence mode

- Put S 24 in the WRITE position and S27 in the MAX. position.
- Turn R 2523 fully clockwise, R 2427 fully counter clockwise.
- Put R 2404, R 2423, R 2480, R 2481 and R 2549 in their mid position.
- Connect the probe of the measuring oscilloscope to the front mesh terminal 12 on unit 25. The measuring terminals for the storage electrodes are located near connector S2.
  Turn the persistence control (R16) fully counter clockwise so that the dynamic erase pulses on the front mesh are switched on.
  Adjust the amplitude of these pulses by means of R 2423 to 8 Volt.

- Adjust the store level V1 (the lower level of the dynamic erasure pulses) on the front mesh to 0 Volt by means of R 2577.
  Remove the probe.
  The pulses can be measured with the oscilloscope itself.
  The store level is normally 0 Volt; however in some cases a voltage that is somewhat different from this gives a better result!

  This may be necessary if it is impossible to obtain background illumination in FAST mode.

- Turn the intensity control (R14) to minimum.
  Turn the persistence control (R16) to its first clockwise stop (not in the MAX position) so that the dynamic erase pulses on the front mesh are switched off.
  Adjust the voltage on collimator 2 to the lowest possible value by means of R 2523. The borders of the illuminated area on the CRT screen must be just invisible, when releasing the erase button.
  These borders can be recognised because they light up at a high intensity. If necessary this can also be checked in the MAX WRITE mode for a better definition.

- Operate the erase pushbutton (S25) and adjust by means of R 2427 the erase pulse voltage V2 so that the CRT screen is just black.
  Repeat this procedure to obtain optimum result.

- In the MAX WRITE position the storage level is increased a little and the background illumination on the CRT screen can be adjusted to the desired value by means of R 2414.

- The illumination of the left half and the right half of the CRT screen must be equal. This must be adjusted by means of R 2480 which determines the cathode current of the left and the right flood gun system.
- Put the instrument in the MEMORY OFF mode and switch to EXT X DELF mode with the vertical input coupling switch in the "0" position. Check the location of the spot, that appears on the screen by turning the INTENS control R14 up. After this turn R14 back to its anti-clockwise stop.
- Put the instrument in the MAX WRITE mode.
  Adjust R 2064 on unit 11 so that the spot is just not visible, also after 1 minute of waiting.
- Put the instrument in the WRITE mode.
- Apply a signal of 32 div/2,5 kHz. to the instrument.
- Check that this signal can be written in; if this is not possible check if the vertical and horizontal focusing is alright.
- Check if the intensity of the written in signal is equal over the entire screen: if not readjust R 2481. If this will not give a reasonable result it may be necessary that the memory meshes must be demagnitised. This can be done with a demagnitising coil held during 1 min. in front of the screen: See chapter 5.
- Check the storage time: this must be 1 min.
- If writing speed or storage time is insufficient readjust R 2427 in the way that is described above.

- Put the instrument in the MAX WRITE mode.
- Apply a signal of 32 div/25 kHz to the instrument.
- Check if this signal can be written in.
- Check the storage time: this must be 15 sec.
- If writing speed or storage time is insufficient readjust R 2414 in the way that is described above.

8.3.13.5. Adjustment of the fast mode

- Put S 24 in the FAST position and S 27 in the MAX. position.
- Adjust the instrument in the MEMORY OFF mode in such a way that a 10MHz/8DIV. sinewave gives stable triggering. Switch after that to the FAST mode.
- Turn R 2408, 2412, 2419 and 2429 fully counter clockwise.

- Turn the intensity control to minimum. Depress the erase button and adjust by means of R 2429 the erase pulse voltage so that the CRT screen is nearly just black; a small rest of background illumination is necessary.
- Turn the intensity control to maximum and increase the amplitude of the 10MHz signal to 32 divisions. Operate the erase button and adjust by means of R 2412 the voltage V5 so that the signal becomes visible. Adjust R 2412 for optimum result. Readjustment of the focus could be necessary.
- Check the storage time: this must be 15 sec.
- Adjust the pulse voltage on the collimator 3 by means of R 2404 to an equal background illumination over the whole screen. R 2549 must be used to adjust the intensity of the background clouds (the so-called "lungs").

  Repetitive erasure and adjustment is necessary to obtain an optimum result.

- Operate the erase button and write a signal immediately.
  Remember the recorded picture.
  Turn the trigger level R7 fully to the left or right so that the time base is not triggered. Operate the erase button and wait 5 seconds. Turn R7 back and write the signal.
  Now compare the two pictures. If the second picture has a lower intensity, turn R 2408 clockwise but keep it as counter clockwise as possible and repeat the procedure; readjustment of R 2412 could be possible but is mostly not necessary. Repeat the adjusting procedure in order to obtain a stable functioning.

- Adjustment of R 2419 is not necessary, fully counter clockwise is sufficient.
- If after adjustment of the storage section the writing speed is insufficient the adjustment of the writing gun must be checked.
  The adjustment is correct if:
  - A sinewave signal of 10MHz and 8 divisions height can be written.
  - The modulation pulse on G1 of the CRT during writing, in position magn. X10 (S3) is at least 75V. To avoid excessive voltages, the modulation pulse can be measured at the emitter of V2013 on the Z amplifier.
  - The defocusing in horizontal direction on the left half and right half of the CRT screen is minimal and symmetrical.

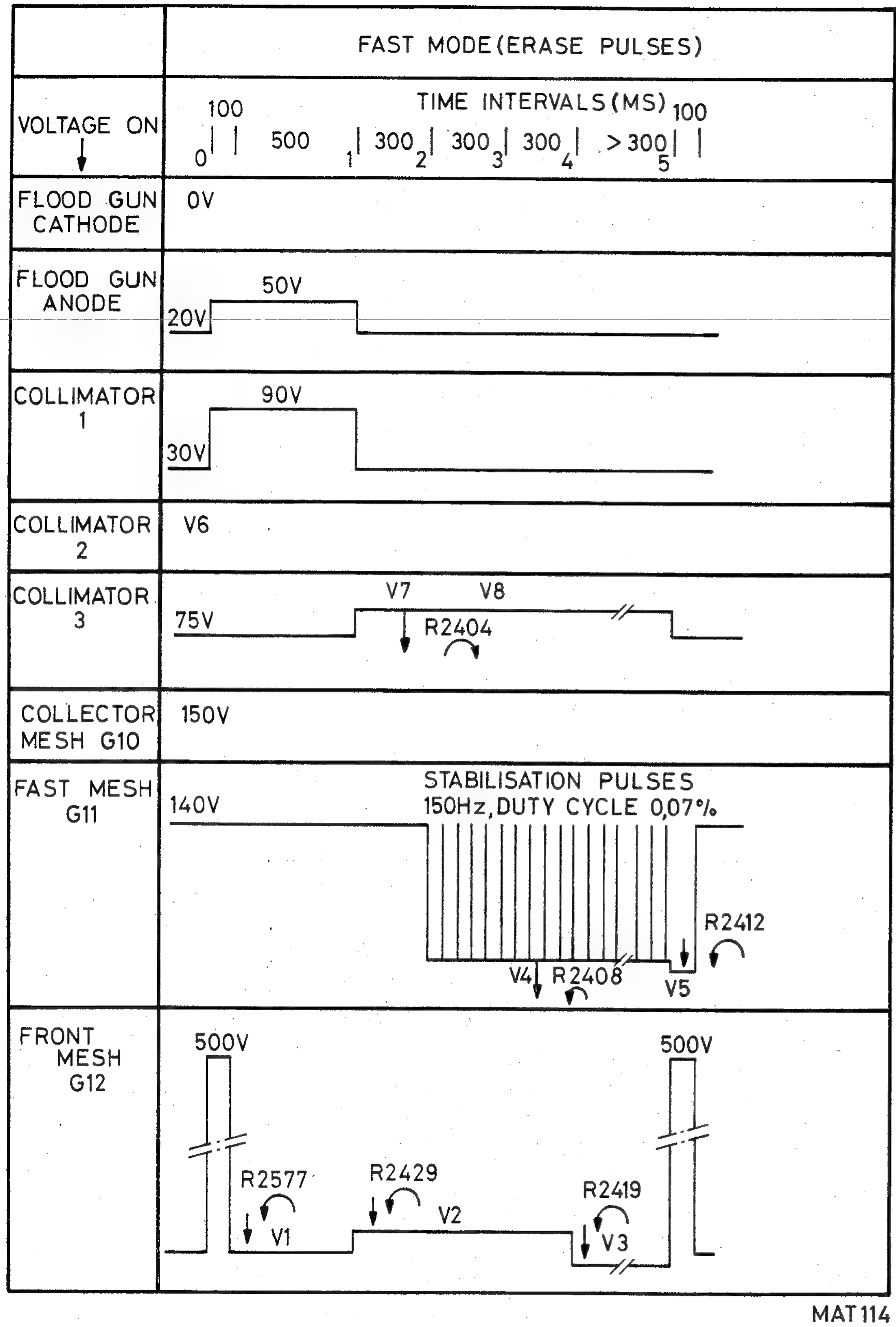


Fig. 8.7. Adjustments of the FAST mode

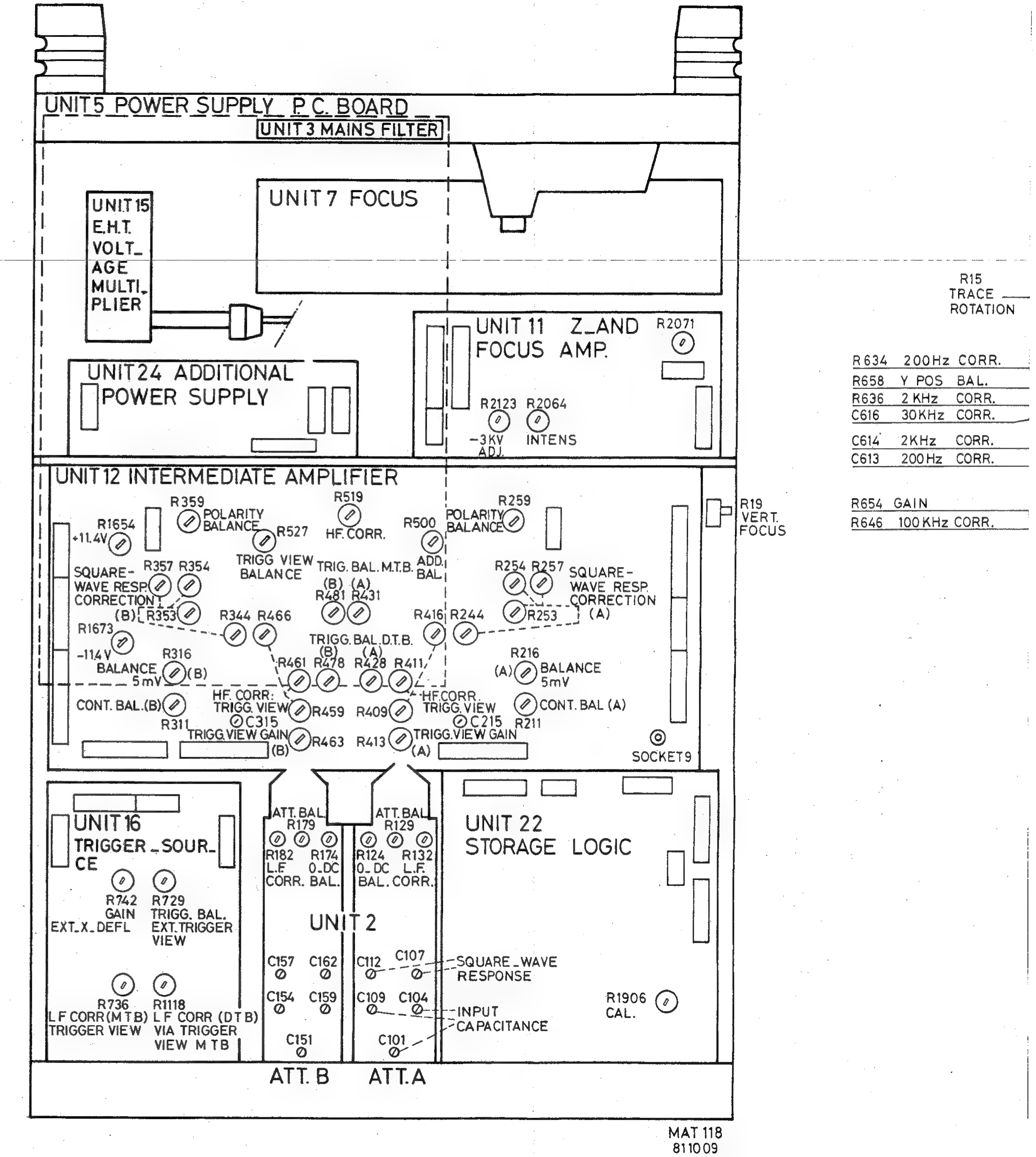


Fig. 8.8. Unit lay-out adjustment points, bottom view

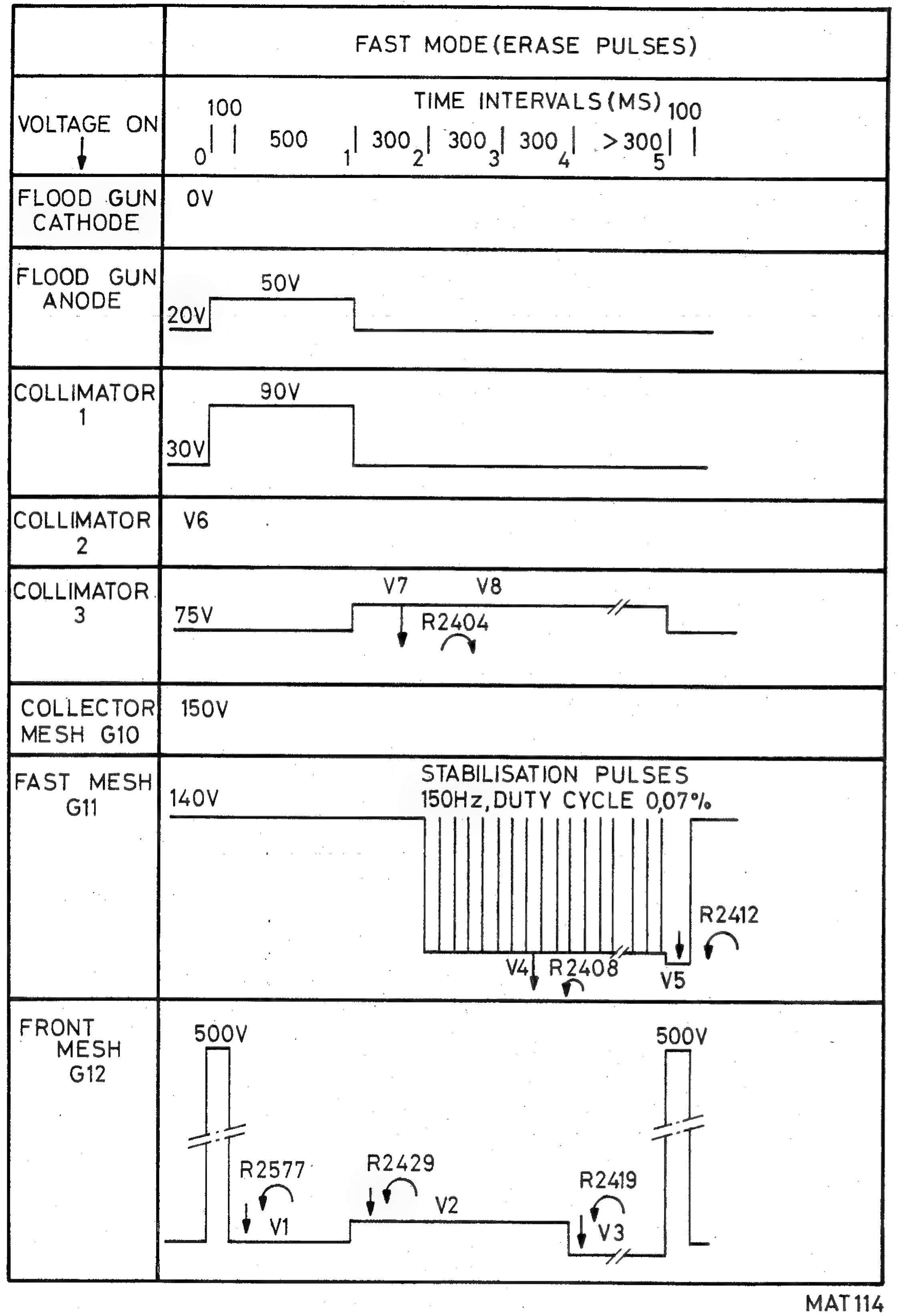


Fig. 8.7. Adjustments of the FAST mode

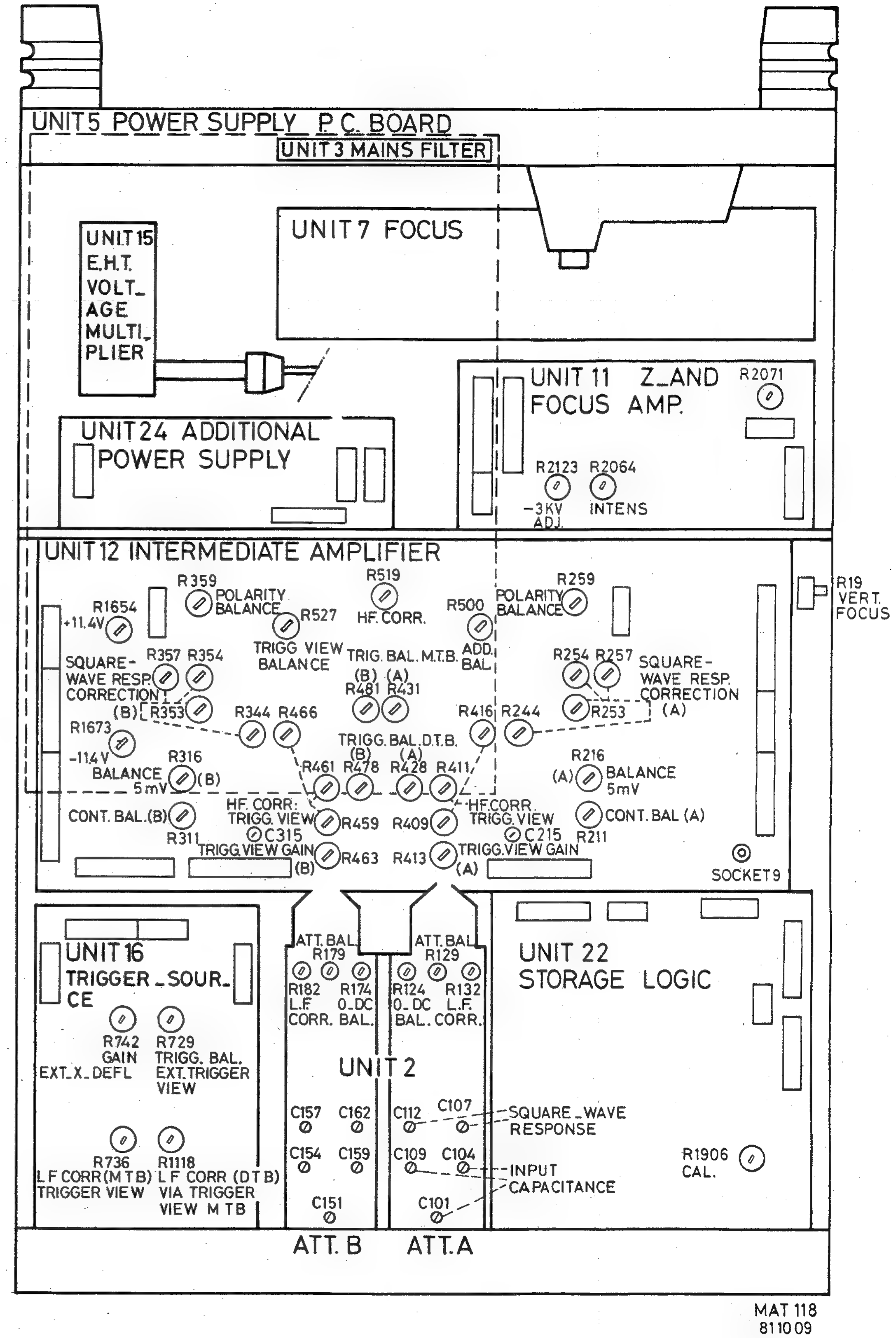


Fig. 8.8. Unit lay-out adjustment points, bottom view

R15 TRACE ROTATION

R634 200Hz CORR.
R658 Y POS BAL.
R636 2 KHz CORR.
C616 30KHz CORR.
C614 2KHz CORR.
C613 200Hz CORR.

R654 GAIN
R646 100KHz CORR.

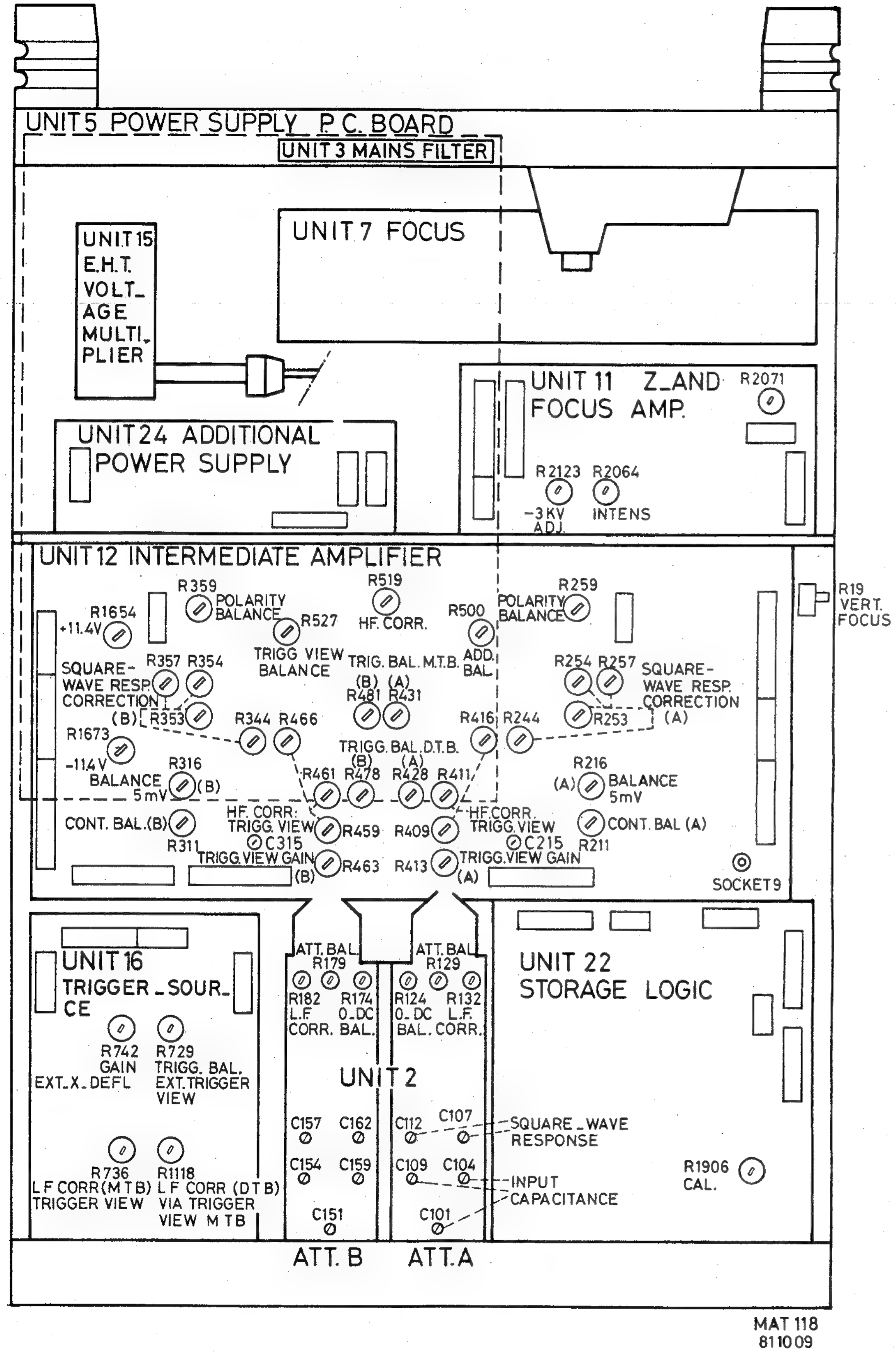


Fig. 8.8. Unit lay-out adjustment points , bottom view

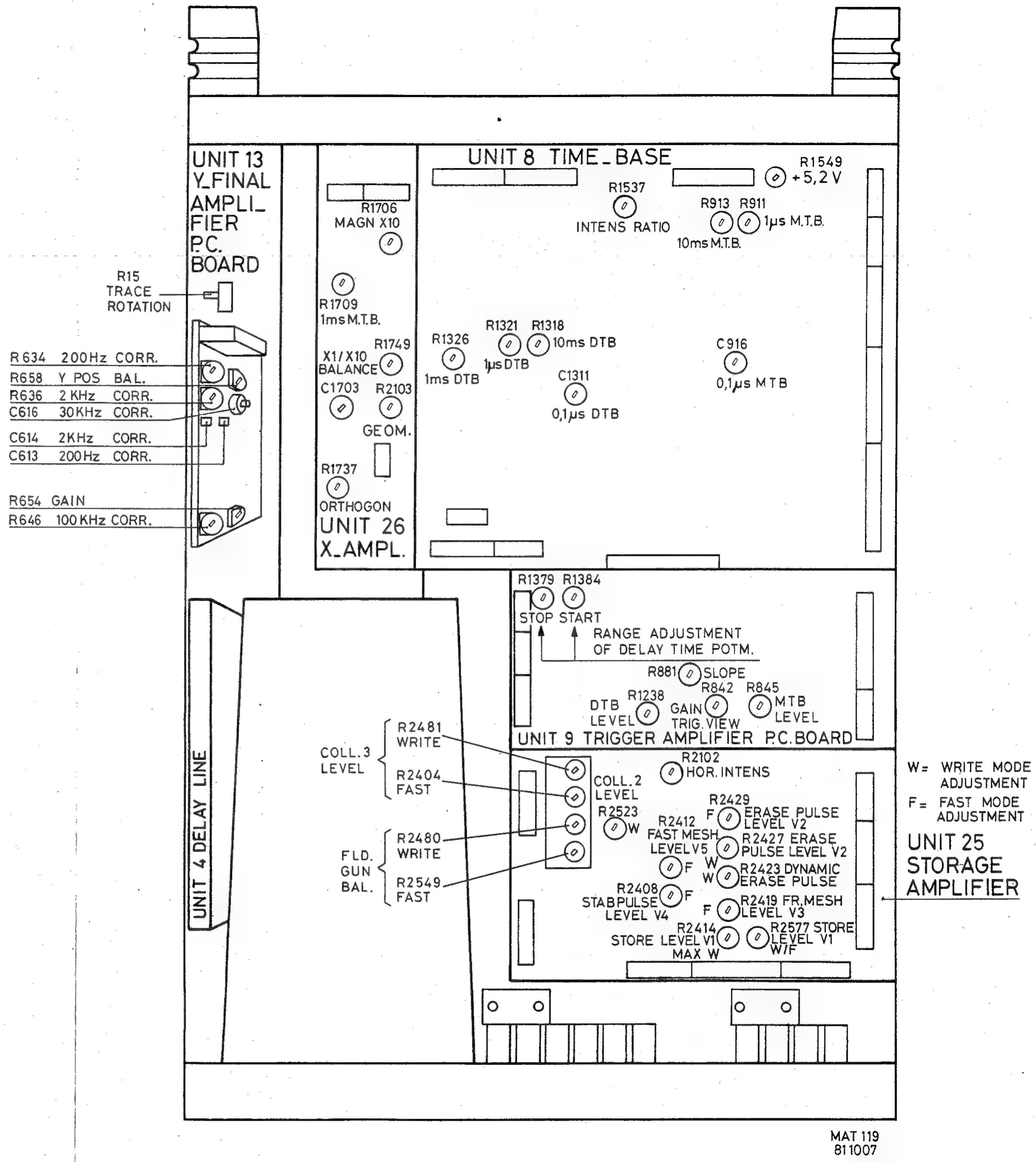


Fig. 8.9. Unit lay-out & adjustment points,top view

8.3.13.6. Demagnitising coil: how to make it and how to use it

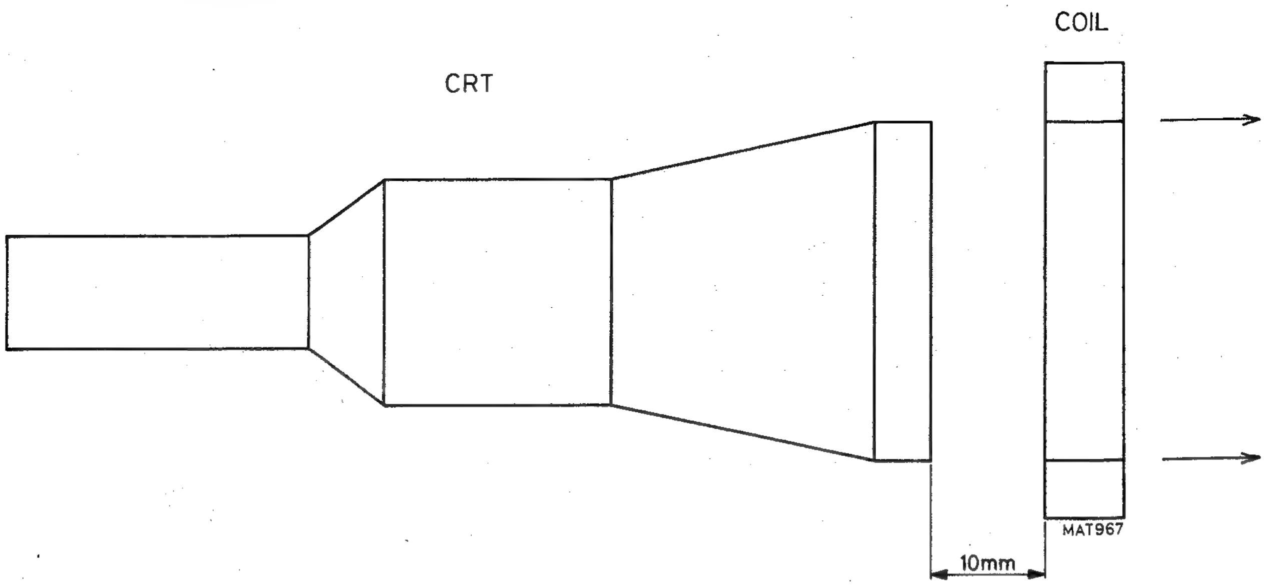


Fig. 8.10. Demagnitising coil, dimensional drawing

The coil holder can be made out of a plastic cable troughing and must be filled up completely with isolated copper wire with a core diameter of 0,8 mm.: see the dimensional drawing in fig. 8.10.

Apply the demagnitising coil to an AC voltage of 100 Volt/50 ... 60Hz. This voltage can be obtained from a variable mains transformer. The coil must be held during 10 seconds at a distance of 10 mm. from the CRT screen as indicated in fig. 8.11. After this 10 second period move the coil gently from the CRT screen in the direction indicated in the figure. After this switch the coil off.

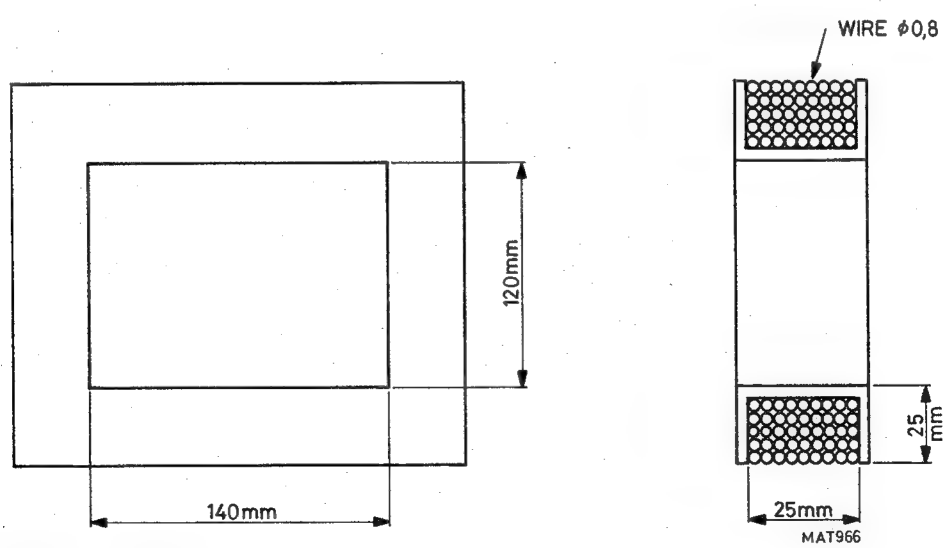


Fig. 8.11. Demagnitising coil, how to use it

9. CORRECTIVE MAINTENANCE

Warning:

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live. The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened. If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved. Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

9.1. IMPORTANT NOTES

Section 9 provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed.
Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute after switching off the instrument.

Warning:

The E.H.T. cable is unbreakably connected to the C.R.T. (disconnection at E.H.T. voltage multiplier). When the E.H.T. cable to the post-acceleration anode of the C.R.T. is disconnected at the E.H.T. unit end, the E.H.T. cable must be discharged immediately by shorting them to the instrument earth.

9.2. REPLACEMENTS

9.2.1. Standard parts

Electrical and mechanical part replacements can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers.
Before purchasing or ordering replacement parts, check the parts list for value tolerance, rating and description.

Note:

Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

9.2.2. Special parts

In addition to the standard electronic components, some special components are used. These components are manufactured or selected by Philips to meet specific performance requirements.

9.2.3. Transistors and integrated circuits

Transistors and IC s (integrated circuits) should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.
Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced.

Warning:

Silicone grease is used to facilitate the conduction of heat between power transistors and their heatsink (for instance V1806/unit 5). Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

9.3. REPLACING KNOBS

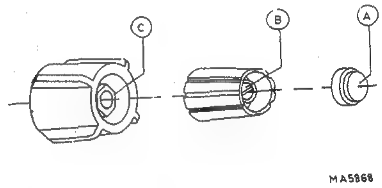
Single knobs

- Prise off cap A
- Slecken screw (or nut) B
- Pull the knob from the spindle

Double knobs

- Prise off cap A and slacken screw B
- Pull the inner knob from the spindle
- Slacken nut C and pull the outer knob from the spindle

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.



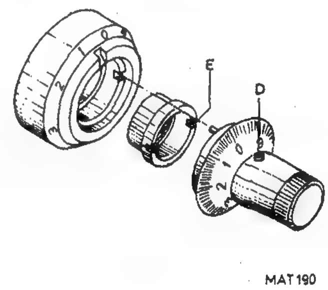


Fig. 9.1. Removing the knobs

Delay-time multiplier knob

- Slacken screw D using a hexagonal key and pull the knob from the spindle
- Remove the nut E and withdraw the ring from the spindle.

When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut E. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw D.

9.4. SOLDERING TECHNIQUES AND SPECIAL TOOLS

9.4.1. General

Ordinary 60/40 solder and 35– to 40-watt pencil-type soldering iron can be used for the majority of the soldering. If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material.

9.4.2. Micro-miniature semi-conductors

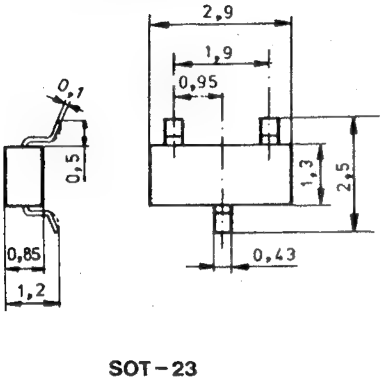


Fig. 9.2. Dimensional drawing of SOT-23 encapsulation

Because of the small dimensions of these SOT semi-conductors and the lack of space between the components on the printed-circuit board, it is necessary to use a miniature soldering iron with a pin-point tip (max. dia 1 mm) to solder a SOT on to a printed-circuit board.

Working method:

- Carefully unsolder one after the other the soldering tags of the semi-conductor.
- Remove all superfluous soldering material. Use a sucking iron or sucking copper litze wire.
- Check that the tags of the replacement part are clean and pre-tinned on the soldering places.
- Locate the replacement semi-conductor exactly in place, and solder each tag to the relevant printed conductor on the circuit board.

Note:

Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250 deg C. The use of a solder with a low melting point is therefore recommended.

Take care not to damage the plastic encapsulation of the SOT during the soldering procedure (softening point of the plastic is 150°C).

Attention:

When soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to the mass of the oscilloscope.

Suitable soldering irons are:

- ORYX micro-miniature soldering instrument, type 6A, voltage 6 V, in combination with PLATO pin-point tip type 0-569.
- ERSA miniature soldering iron, type minor 040 B, voltage 6 V.
- Low Voltage Mini Soldering Iron, Type 800/12 W - 6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with 1 mm-pin-point tip, order no. 4822 395 10012.

9.4.3. Special tools

Special tool for the slotted nut of attenuator switches A, B, C and D, order no. 5322 395 54023

For those who want to make such a tool, a sketch is given with the dimensions in mm in fig. 9.3. The material is silver steel N094, tempered 40-45 Rc.

Special tool for the slotted nut of the POSITION and LEVEL/SLOPE potentiometers, order no. 5322 395 54024

For those who want to make such a tool, a sketch is given with the dimensions in mm in fig. 9.4. The material is silver steel N094, tempered 40-45 Rc.

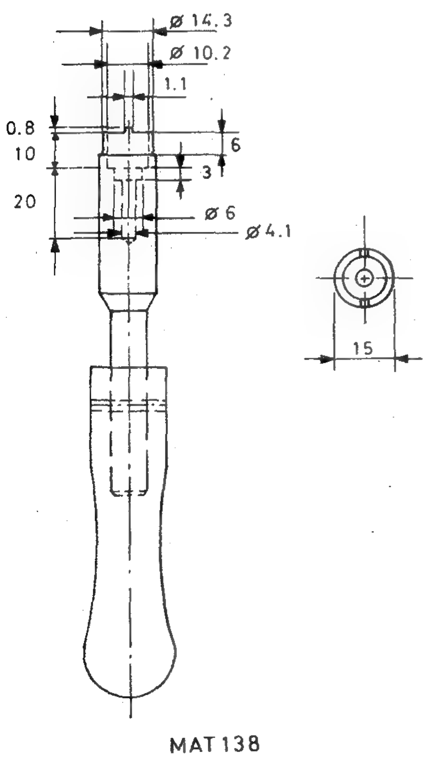


Fig. 9.3. Tool for attenuator unit

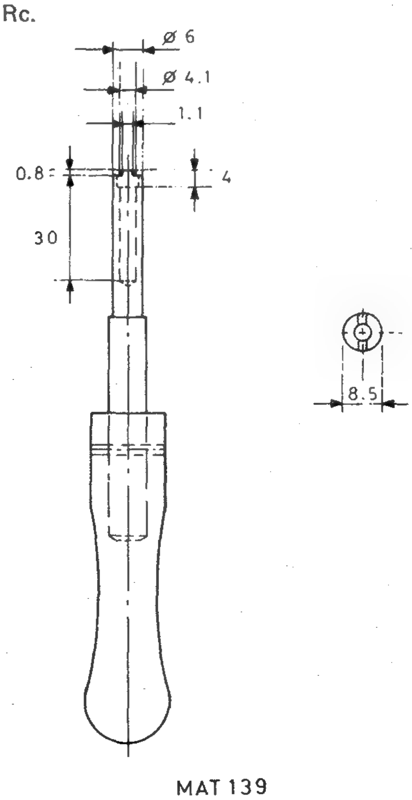


Fig. 9.4. Tool for level potentiometer

9.5. REPLACING A PUSH-BUTTON SWITCH

Each of the pushbutton sets is fitted to the front panel by means of two clamping devices secured by hexagon screws, see fig. 9.5.

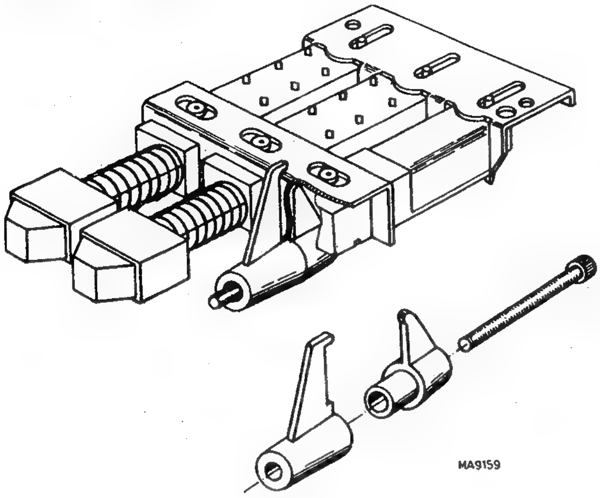


Fig. 9.5. Push-button set clamping device

To remove a pushbutton switch, the hexagon screws that secure it to the front panel must be removed. To replace one switch-section of a push-button set, refer to fig. 9.6.

To remove a pushbutton switch which is mounted on a p.c. board:

- Remove the printed-circuit board for replacing a switch in this unit.
- Straighten the 4 retaining lugs of the relevant switch as shown in fig. 9.6.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-circuit board.
- Bend the 4 retaining lugs back to their original positions.

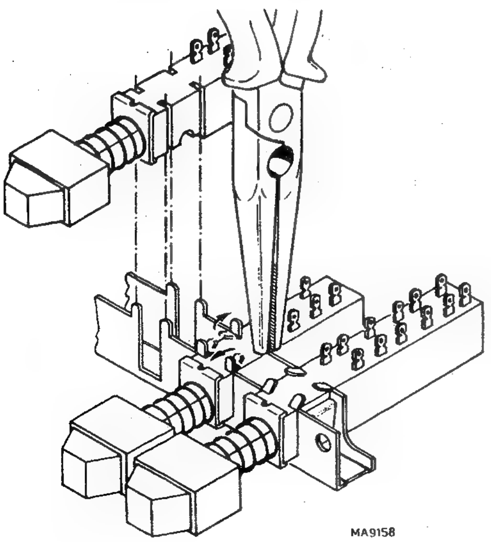


Fig. 9.6. Replacing a switch-segment of a push-button set

Note:

Before a pushbutton switch is refitted to the front panel, it is advisable to stick the two parts of the clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate replacement, refer to fig. 9.5.

9.6. RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits.
Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done on the power supply.

9.7. INSTRUMENT REPACKING

If the instrument is to be shipped to a Service Centre for service or repair, attach a tag showing owner (with address) and the name of an individual at your firm who can be contacted. The Service Centre needs the complete instrument serial number and a fault description.
Save and re-use the packing in which your instrument was shipped. If the original packing is unfit for use or not available, repack the instrument in such a way that no damage occurs during transport.

9.8. TROUBLE-SHOOTING (General)

9.8.1. Introduction

The following information is provided to facilitate trouble-shooting. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuits are used. Refer to the Circuit Description section for this information.

9.8.2. Trouble-shooting hints

If a fault appears, the following test sequence can be used to find the defective circuit part:

- Check if the settings of the controls of the oscilloscope are correct. Consult the operating instructions in this manual (Section 3)
- Check the equipment to which the oscilloscope is connected and the interconnection cables.
- Check if the oscilloscope is well-calibrated. If not, refer to section 8 (checking and adjusting).
- Visually check the part of the oscilloscope in which the fault is suspected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC s that are not correctly plugged into their sockets.
- Location of the circuit part in which the fault is suspected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes. Check the voltage between base and emitter (0,7 Volt approx. in conductive state) and the voltage between collector and emitter (0,2 Volt approx. in saturation) with a voltmeter or oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the base/emitter and base/collector junctions can be regarded as diodes. Like a normal diode, the resistance is very high in one direction and low in the other

direction. When measuring take care that the current from the ohmmeter does not damage the component under test.
Replace the suspected component by a new one if you are sure that the circuit is not in such a condition that the new one will be damaged.

- Integrated circuits. In circuit testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under test is essential. Therefore first read the circuit description in section 3.
- Capacitors. Leakage can be traced with an ohmmeter adjusted to the highest resistance range. When testing take care of polarity and maximum allowed voltage. An open capacitor can be checked if the response for AC signals is observed. Also a capacitance meter can be used: compare the measured value with value and tolerance indicated in the parts list.
- Resistors. Can be checked with an ohmmeter after having unsoldered one side of the resistor from the p.c.b. Compare the measured value with value and tolerance indicated in the parts list.
- Coils and transformers. An ohmmeter can be used for tracing an open circuit. Shorted or partially shorted windings can be found by checking the wave-form response when HF signals are passed through the circuit. Also an inductance meter can be used.

Note:

If a component must be replaced always use a direct-replacement. If not available use an equivalent after carefully checking that it does not degrade the instrument's performance. See also section 6.2. (replacement).
After replacement of a component the calibration of the instrument may be affected due to component tolerances. If necessary do the required adjustments.

9.9. REPLACING THE CARRYING HANDLE

1. Remove the upper and lower cabinet plates
2. Remove the plastic strip which is snapped on to the grip.
3. Remove the four screws which secure the grip to the brackets (these screws have been locked with a sealing varnish).
4. Depress the pushbuttons in the brackets and turn the carrying handle as far as possible to the upper side of the oscilloscope.
5. Keep the pushbutton of the righ-hand bracket depressed and pull the bracket from its bearing [1]).
6. Remove the grip from the remaining bracket.
7. Depress the pushbutton of the left-hand bracket and turn the latter as far as possible to the lower side of the instrument.
8. Keep the pushbutton depressed and pull the bracket from its bearing.
   If it is impossible to remove the left-hand bracket in this way, remove also its bearing in a similar way as described in footnote [1]).

[1]) With some instruments it may be impossible to remove the handle in the described way. This is due to an extra securing plate in the right-hand bearing. In that case, DO NOT USE FORCE, but work in accordance with the following procedure which replaces points 3, 4 and 5.

3. Remove the two screws which secure the grip to the right-hand bracket.
4. Remove the two hexagonal bolts which secure the right-hand bearing to the side strip.
5. Depress the pushbutton of the right-hand bracket and take the bearing from the bracket.

9.10. REPLACING THE CATHODE RAY TUBE (CRT)

Warning:

> Handle the CRT carefully. Rough handling or scratching can cause the CRT to implode. In particular be very careful with the side connections of the CRT. If these pins are bent the CRT is likely to develop a loss of vacuum.

- Remove the top cover, bottom cover, black metal screening plate and the rear plate.
- Carefully remove the CRT side connections.
- Unplug the stocko plug that connects the CRT storage electrodes with the storage amplifier unit.
- Disconnect the trace rotation wires on the final X-amplifier.
- Disconnect the EHT cable and discharge it.
- Remove the tube base.
- Remove the screen bezel by pulling the lower edge.
- Remove the final X-amplifier as described in section 9.11.
- Remove the final Y-amplifier as described in section 9.11.
- Slacken the two screws that secure the upper CRT screen support to the front panel and disconnect the earth connection for the CRT shield.
- Slacken the brace round the CRT neck.
- Remove the two screws that connect the rubber CRT holder to the rear panel.
- Carefully slide the screen side of the CRT into the shield
- Now there is enough space to take the CRT, shield and rubber socket upwards out of the instrument.
- Now the CRT, shield and socket can be separed.

Attention: If the rubber socket round the CRT neck must be slid over the neck of a replacement tube, the use of industrial talcum powder is strongly recommended to prevent the rubber socket from sticking on the CRT neck.

9.11. Removing the printed circuit boards

Storage logic (Unit 22)

- This unit is equipped with MOS devices that are very sensitive to static discharges. To ensure safe handling refer to chapter 6.9.: "Handling MOS Devices".
- Pull of the knobs from R14, R16 and R17.
- Remove the long shaft from R14.
- Remove two clamping pieces that attach the unit to the front panel.
- Unplug the stocks plugs, coax plugs and other connections.
- Pull the LED out off the front panel.
- Slacken three screws and take the unit out of the instrument.

Attenuator (Unit 2)

- Remove the shielding plate at the bottom side of the attenuator (remove 8 screws).
- Unplug the appropriate multipole connectors and coaxial cables.
- Remove the V/DIV attenuator knob.
- Remove the two Allen-key screws, which clamp the attenuator at the bottom side to the front-panel.
- Remove the two central nuts which clamp the attenuator to the frontpanel.
- The attenuator can be removed by shifting it backwards and have it leaving the instrument via the bottom side.

IMPORTANT

Due to the complexity of the attenuator unit it has been decided to put this unit into the central repair procedure of Concern Service in Eindhoven / The Netherlands. For procedure details contact your national Philips Service Organisation.
Well equipped workshops however could be able to do the following:

- Measurements on the p.c.b.
- Replacing components on the p.b.c.
- Replacing the p.c.b. It is possible to remove the p.c.b. without removing the control array. This array can stay positioned with one screw in the middle between the channel A and B sections.
- Replacing the UNCAL LED's V4 and V5.
- Replacing the plastic potentiometer axes.
- Replacing the vertical continuous ampl./div. control potentiometers R8 and R9.
- Replacing the switch segment S9/S11.

We advise against replacement of the contact array and the GAIN potentiometers. For mounting these parts special production tools are required for an optimal result.

Trigger source selector (Unit 16)

- Unplug the four multipole connectors.
- Remove the two hexagon screws that secure the board to the front panel.
- Unscrew the two screws at the rear side of the board.
- Unsolder the wires at the components side of the board.
- Unplug the two miniature coaxial plugs at the soldering side of the board.
- Carefully lift the unit out of the oscilloscope.

Intermediate amplifier (Unit 12)

- Remove the various plugs.
- Unscrew the screws that secure the unit to the chassis.
- Unsolder the delay line connections.

Z-amplifier (Unit 11)

- Remove the black metal screening plate.
- Desolder 7 connections coming from the focus unit.
- Unplug the stocko plugs, coax plugs, and other connections.
- Remove three distance pieces and one screw and take the unit out.

Additional power supply (Unit 24)

- Remove the black metal screening plate.
- Unplug the stocko plugs and other connections.
- Remove four screws and take the unit out.
- When mounting the unit, don't forget to mount the earth tap for focus and EHT unit !!

Focus unit (Unit 7)

- Remove the black metal screening plate.
- Desolder seven connections on the Z-amplifier unit.
- Remove the rear plate and gently take off the CRT socket.
- Unplug the –3 kV plugs on the additional power supply unit.
- Unplug the connections on the power supply.
- Remove the remaining connections.
- Unscrew six screws and take the unit out of the instrument.

E.H.T. unit (Unit 15)

- Remove the black metal screening plate.
- Unplug the two single-wire connectors to the power supply board (unit 5).
- Disconnect the E.H.T. connector after unscrewing the swivel nut and discharge the cable.
- To extract the E.H.T. unit, swivel out by applying slight pressure to one side of this unit.
- Before screwing the E.H.T. cable on to a replacement E.H.T. unit, the E.H.T. connector should be greased with Silicon Dielectric Compound. Order no. 4822 390 20023.

power supply (Unit 5)

- Remove the lower cabinet plate.
- Remove the rear plate of the instrument (2 screws).
- Remove the black metal screening plate.
- Remove the two screws which secure the circuit board to the rear panel.
- Remove the two screws which secure the circuit board to the bottom side of its compartment.
- Unplug the three multipole connectors and disconnect the two single-wire connectors to the FOCUS p.c. board (unit 7).
- Disconnect the two single wire connectors to the E.H.T. voltage multiplier (unit 15).
- Carefully withdraw the circuit board from its compartment.

Storage amplifier (Unit 25)

- This unit is equipped with MOS devices that are very sensitive to static discharges.
  In order to ensure safe handling refer to chapter "Handling MOS Devices".
- Unplug stocko plugs and other connections.
- Unscrew three screws.
- Remove high tension shield and distance piece and take the unit out of the instrument.

Trigger amplifier unit (Unit 9)

- Unplug stocko plugs, coax plugs and other connections.
- Unscrew three screws.
- Gently slide the unit out of the connector on the time-base unit.

Final X-amplifier (Unit 26)

- Unplug stocko plugs and other connections.
- Unplug very carefully the three CRT connections.
- Unscrew two screws and gently slide the unit out of the connector on the time-base unit.

Time-base unit (Unit 8)

- Remove the trigger amplifier as described
- Remove the final X-amplifier as described
- Unplug stocko plugs, coax plugs and other connections.
- Unscrew five screws and take the unit out of the instrument.

Final Y-amplifier (Unit 13)

- Remove the two screws which secure the bracket to the side strip.
- Disconnect the miniature coaxial plugs.
- Unplug the multipole connector.
- Remove the delay-line connections.
- Disconnect the wires from the C.R.T.-pins and carefully lift out the circuit board.

Delay line (Unit 4)

- Remove the connections on intermediate amplifier and final Y-amplifier.
- Unscrew two screws and take the delay line out of the instrument.

10 EXTRA IN- AND OUTPUTS

10.1. INTRODUCTION

The PM 3266 is equipped with a Z-MOD input mounted at the rear panel and with facilities to add two extra outputs with a minimum of components. The output sockets are mounted in the holes already present in the rear panel.

External Z-modulation input

Characteristics:

- DC coupled
- TTL compatible
- "Positive polarity" blanks display
- Response time 35 ns
- Input impedance 10 kΩ
- Max. input voltage 50 V.

10.2. MAIN TIME-BASE GATE OUTPUT (OPTIONALLY AVAILABLE)

Characteristics:

- Output voltage 0 .... +5 V delivered during MTB sweep.
- Output impedance 1 kΩ.

Fitting the output:

- Fit the connector in the relevant hole in the rear panel of the oscilloscope.
- Connect one end of the coaxial cable to the coax socket MTB gate out on the time-base unit (unit 8): this socket is indicated on the unit lay-out.
  Connect the other end of this cable to the BNC connector on the rear panel.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

- BNC connector — ordering code 5322 267 10004
- Coax Cable (per meter) — ordering code 5322 320 10003

10.3. DELAYED TIME-BASE GATE OUTPUT (OPTIONALLY AVAILABLE)

Characteristics:

- Output voltage 0 ... +5 V delivered during DTB sweep.
- Output impedance 1 kΩ.

Fitting the output:

- Fit the connector in the relevant hole in the rear panel of the oscilloscope.
- Connect one end of the coaxial cable to the coax socket DTB gate out on the time base unit (unit 8): this socket is indicated on the unit lay-out.
  Connect the other end of this cable to the BNC connector on the rear panel.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

- BNC connector — ordering code 5322 267 10004
- Coax Cable (per meter) — ordering code 5322 320 10003

11. PARTS LIST (SUBJECT TO ALTERATION WITHOUT NOTICE)

11.1. MECHANICAL PARTS (FIG. 11.1. AND 11.2.)

Item	*Qty*	*Order number*	*Description*	*Used for*
3	1	5322 414 34147	Ten turn dial knob delay time	R1
		5322 414 34091	Knob dia 10 mm, 4 mm shaft	R3/S4
2	3	5322 414 74028	Skirt	R4/S5
		5322 414 74015	Cover grey with line	R18
5	3	5322 414 34191	Knob dia 10 mm, 4 mm shaft	R5/S6 R7/S7
		5322 414 74015	Cover grey with line	R2/S3
4	1	5322 414 34217	Knob dia 6,7 - 10 mm, 4 mm shaft	R6
		5322 492 64337	Clamping spring	
		5322 414 34079	Knob dia 18,7 mm 6 mm shaft	
14	2	5322 414 34134	Knob dia 10 mm, 4 mm shaft	R8/S9/S10
		5322 492 64337	Clamping spring	R9/S11/S12
		5322 414 74029	Cover blue with line	
		5322 414 34081	Knob dia 24 mm, 6 mm shaft	R10/S13/S14
12	2	5322 414 34119	Knob dia 14 mm, 4 mm shaft	R11/S15/S16
		5322 414 74016	Cover blue with dash	
		5322 414 34223	Knob dia 14 mm, 4 mm shaft	R14/S23
18	3	5322 492 64337	Clamping spring	R16/S26
		5322 414 74015	Cover grey with line	R17
17	30	5322 414 14011	Pushbutton knob grey	
16	1	5322 414 24911	Pushbutton knob red	
		5322 267 14014	CAL socket	
20	1	5322 505 14184	Plastic nut	X1/X2
		5322 405 94073	Current loop	
		5322 263 54003	BNC adaptor for CAL socket	
15	5	5322 267 10004	BNC socket	X3,4,6,7,8
13	1	5322 535 80523	Earth socket	X5
		5322 505 14178	Serrated nut	
21	1	5322 466 74059	Screen bezel	
1	1	5322 480 34046	Contrast filter grey	
1	1	5322 480 34074	Contrast filter blue	
	1	5322 498 54082	Set grip and brackets	
	2	5322 528 34113	Ratchet block	Carrying handle
	2	5322 535 74401	Locking pin	
19	2	5322 492 54155	Spring	Carrying handle
	1	5322 498 54042	Plastic protection strip	
	1	5322 455 84079	Text strip PM 3266	
	1	5322 447 94169	Front cover complete	
7	1	5322 447 94482	Upper cabinet plate complete	
11	1	5322 447 94483	Lower cabinet plate complete	
6	8	5322 417 24024	Quick fastener complete	
	4	5322 462 44297	Rubber foot for lower plate	
24	1	5322 447 94503	Rear cabinet plate	
23	4	5322 462 44154	Foot complete for rear panel	
9	1	5322 459 84023	Cast alluminium front plate	
8	1	5322 447 94504	Cast alluminium rear plate	
10	2	5322 460 64042	Side panel alluminium	
	8	4822 502 30047	Screw for fitting side panel	

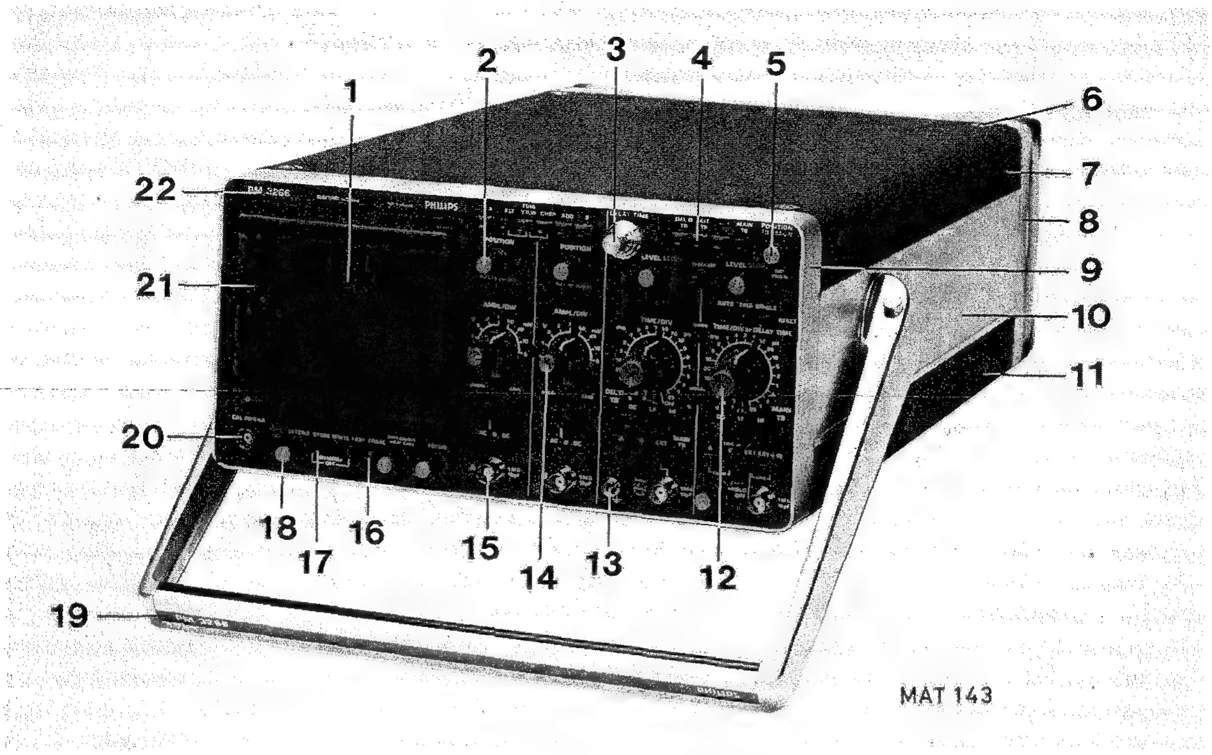


Fig. 11.1. Electrical item numbers, front view

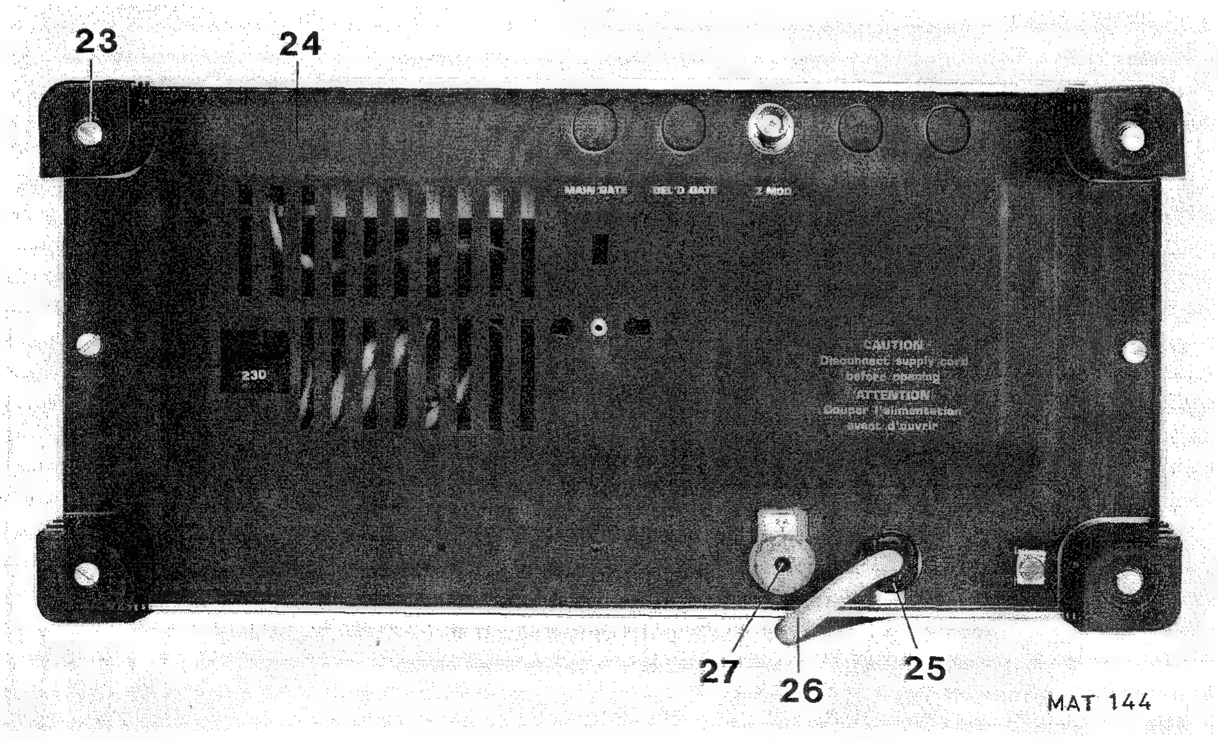


Fig. 11.2. Electrical item numbers, rear view

Item	*Qty.*	*Order number*	*Description*
	–	4822 505 10029	Square nut M3 for side panel
26		5322 321 14066	Mains cable European plug
		5322 321 14017	Mains cable USA plug
25	1	5322 325 64061	Mains cable cleat
27	1	5322 256 34081	Fuse holder
	1	4822 253 30025	Fuse 2 A slow blow
	4	5322 255 44088	Holder for LED
	6	5322 405 94074	Male clamping piece for pushbutton set
	6	5322 405 94075	Female clamping piece for pushbutton set
	6	4822 502 11142	Screw M3x20 for clamping pieces
	1	5322 380 24088	Clamp for CRT screen top
	1	5322 380 24087	Clamp for CRT screen bottom
	1	5322 535 74525	Plastic spindle for R14
	1	5322 532 24398	Coupling piece
	2	5322 535 74526	Plastic spindle for R16 and R17
	2	5322 492 64337	Clamping spring
	2	5322 505 10659	Nut for attenuator switch
	–	5322 395 54023	Tool for attenuator nut
	2	5322 505 14186	Nut for Level/Slope potentiometers
	–	5322 395 54024	Tool for Level/Slope nut
	29	5322 276 14158	Pushbutton switch element
	–	5322 320 14102	Set of coaxial cables
	20	5322 268 24116	PC board vertical coax socket
	20	5322 268 14141	Contact pin for coax socket
	1	5322 455 84078	Textplate PM 3266
	1	5322 466 34013	CRT shield
	–	4822 390 20023	Grease for EHT connector Dow Corning "4 Compound" Silicon Dielectric
	18	4822 265 30121	3 pole socket "stocko"
	18	4822 266 30071	3 pole plug "stocko"
	14	4822 265 30119	4 pole socket "stocko"
	14	4822 266 30072	4 pole plug "stocko"
	16	4822 265 30117	6 pole socket "stocko"
	16	4822 266 30073	6 pole plug "stocko"
	10	4822 265 40119	7 pole socket "stocko"
	10	4822 266 40057	7 pole plug "stocko"
	1	5322 273 14054	MTB switch S15
	1	5322 273 14055	DTB switch S13
	1	5322 219 84135	Attenuator (Unit 2)
	1	5322 216 54202	Attenuator p.c. board
	2	5322 535 94951	Plastic shaft for attenuator
	2	5322 273 34116	Attenuator switch segment S9/S11
	1	5322 121 44261	Mains filter (Unit 3)
	1	5322 320 44039	Delay line (Unit 4)
	1	5322 216 54204	Power supply (Unit 5) if present, remove C1827 that may be in parallel with C1826. C1827 is not required for the PM3266.

Item	*Qty.*	*Order number*	*Description*
	1	5322 216 51002	Focus unit (Unit 7)
		5322 390 34006	"Coating for focus unit Dow Corning 3140 RTV".
	1	5322 216 51012	Time base (Unit 8)
	1	5322 216 54225	Trigger amplifier (Unit 9)
	1	5322 216 51001	Z-amplifier (Unit 11)
	1	5322 216 54237	Intermediate amplifier (Unit 12)
	1	5322 216 54197	Final Y-amplifier (Unit 13)
	1	5322 218 64109	E.H.T. unit (Unit 15)
	1	5322 216 54199	Trigger source selector (Unit 16)
	1	5322 216 54219	Storage logic (Unit 22)
	1	5322 216 51013	Additional power supply (Unit 24)
	1	5322 216 51014	Storage amplifier (Unit 25)
	1	5322 216 54223	Final X-amplifier (Unit 26)

11.2. ELECTRICAL PARTS

Miscellaneous

Item	*Ordering numbers*	*Type/description*
K1701	5322 280 24076	Relay coil
L1	5322 157 44035	Choke
L601	5322 321 24901	R/L combination
L602	5322 321 24901	R/L combination
L1601	5322 156 14076	Choke
L1801	5322 156 14076	Choke
L1802	5322 156 14076	Choke
L1803	5322 142 44026	Driver transformer
L1804	5322 281 64154	Choke
L1806	5322 148 84041	Feed back transf.
L1807	5322 152 24062	Choke
L1811	4822 156 20663	Choke
L1812	4822 156 20663	Choke
L1813	4822 156 20663	Choke
L1814	4822 156 20663	Choke
L1816	5322 152 24067	Choke
L1817	5322 152 24068	Choke
L1876	5322 152 24074	Choke
L1877	5322 152 24068	Choke
L1878	5322 152 24071	Choke
T1801	5322 148 84039	Converter transf.
T1876	5322 146 24446	H.F. transformer
S9	5322 273 34116	Segment switch AC/0/DC
S11	5322 273 34116	Segment switch AC/0/DC
S13	5322 273 44098	Segment switch DTB
S15	5322 273 44097	Segment switch MTB
S1801	5322 277 24071	Mains voltage selector

Spare parts for pushbutton switches:

a) Dual change over switch with spring for use with a reset bar.
Ordering code: 5322 276 14101.
In each instrument there are 30 pieces.

b) Dual change over switch with spring for use with reset bar (release key for single shot function).
After having been depressed the push-button returns to its rest position.
Ordering code: 5322 276 14359.
In each instrument 1 piece.

c) Reset bar for max. 6 switches.
The bar can be used for max. 6 switches that have a distance of 10,16mm from each other.
When the bar is needed for a unit with e.g. four switches it must be sawn to the required size.
When doing this take care that the distance between the last stud and the end of the bar is exactly 4,1mm.
When one switch in a unit needs no reset bar (e.g. an independent switch such as "erase") then remove at the relevant spot the stud from the bar with a pair of pincers.
The spring for the reset bar will be delivered together with the switch segments.
Ordering code: 5322 278 74007.
In each instrument there are 7 pieces.

d) Supports for max. 6, 11 and 12 switches.
The supports can be sawn to the required size.
Ordering code:

Max. 6 switches	: 5322 466 85841	Notch distances 4 x 10,16mm and 1 x 25,4mm.
Max. 11 switches	: 5322 466 85843	Notch distances 10 x 10,16mm.
Max. 12 switches	: 5322 466 85842	Notch distances 10 x 10,16mm and 1 x 25,4mm.

Itemnumbers of e.g. C, R, V have been divided in groups which are located on the following units:

Item number	*Unit name*	*Unit number*
1 ... 99	Front or rear plate of the instrument	–
100 ... 199	Ch. A and B attenuator	2
200 ... 599	Intermediate amplifier	12
600 ... 699	Vertical final amplifier	13
700 ... 799	MTB external input unit	16
800 ... 899	MTB trigger circuit	9
900 ... 999	MTB sweep circuit	8
1000 ... 1099	MTB time/div switch	–
1100 ... 1199	DTB external input unit	16
1200 ... 1299	DTB trigger circuit	9
1300 ... 1399	DTB sweep circuit	8
1400 ... 1499	DTB time/div switch	–
1500 ... 1549	X-deflection selector	8
1550 ... 1599	Time base additional stabilisation	8
1600 ... 1649	Display mode logic	12
1650 ... 1699	Intermediate additional stabilisation	12
1700 ... 1799	Horizontal final amplifier	26
1800 ... 1849	Power supply	5
1850 ... 1874	E.H.T. unit	15
1875 ... 1899	Additional power supply	24
1900 ... 1999	Calibration generator	22
2000 ... 2199	Z and focus amplifier, focus unit	7, 11
2200 ... 2599	Storage logic, storage amplifier	22,25

CAPACITORS

POSNR	DESCRIPTION		ORDERING CODE
C 101	3PF		5322 125 54026
C 102	22NF 10%	630V	4822 121 40278
C 103	47PF 2	100	4822 122 31072
C 104	3,5PF		5322 125 50048
C 106	5,6PF 0,25PF	500	4822 122 31191
C 107	18PF		5322 125 50051
C 108	33PF 10%	50V	5322 122 34105
C 108	10PF		5322 125 50049
C 110	15PF 2	100	4822 122 31058
C 111	1PF 0,25PF	500	4822 122 31182
C 112	18PF		5322 125 50051
C 113	39PF 10%	50V	5322 122 34113
C 114	100PF 2	500	5322 122 31626
C 117	10NF 20%	50V	5322 122 34098
C 118	1,5PF 0,25PF	100	4822 122 30105
C 119	100PF 2	100	4822 122 31316
C 120	2,7PF 0,25PF	100	4822 122 31038
C 121	2,2NF-20+80	40	4822 122 31116
C 122	10NF-20+80	40	4822 122 30043
C 123	5,6PF 0,25PF	100	4822 122 31047
C 124	6,8UF-20+20	16	5322 124 14069
C 126	10NF-20+80	40	4822 122 30043
C 127	6,8UF-20+20	16	5322 124 14069
C 128	10NF-20+80	40	4822 122 30043
C 151	3PF		5322 125 54026
C 152	22NF 10%	630V	4822 121 40278
C 153	47PF 2	100	4822 122 31072
C 154	3,5PF		5322 125 50048
C 156	5,6PF 0,25PF	500	4822 122 31191
C 157	18PF		5322 125 50051
C 158	33PF 10%	50V	5322 122 34105
C 159	10PF		5322 125 50049
C 160	15PF 2	100	4822 122 31058
C 161	1PF 0,25PF	500	4822 122 31182
C 162	18PF		5322 125 50051
C 163	39PF 10%	50V	5322 122 34113
C 164	100PF 2	500	5322 122 31626
C 167	10NF 20%	50V	5322 122 34098
C 168	1,5PF 0,25PF	100	4822 122 30105
C 169	100PF 2	100	4822 122 31316
C 170	2,7PF 0,25PF	100	4822 122 31038
C 171	2,2NF-20+80	40	4822 122 31116
C 172	10NF-20+80	40	4822 122 30043
C 173	5,6PF 0,25PF	100	4822 122 31047
C 174	6,8UF-20+20	16	5322 124 14069
C 176	10NF-20+80	40	4822 122 30043
C 177	6,8UF-20+20	16	5322 124 14069
C 178	10NF-20+80	40	4822 122 30043
C 201	10NF-20+80	40	4822 122 30043
C 203	470PF 10	100	4822 122 30034
C 204	10NF-20+80	40	4822 122 30043
C 206	22PF 2	100	4822 122 31063
C 207	22NF-20+80	40	4822 122 30103
C 208	10NF-20+80	40	4822 122 30043
C 209	22PF 2	100	4822 122 31063
C 211	10NF-20+80	40	4822 122 30043
C 212	22PF 2	100	4822 122 31063
C 214	22PF 2	100	4822 122 31063
C 215	18PF		5322 125 50051
C 216	100NF 10%	250V	4822 121 41161
C 217	10NF-20+80	40	4822 122 30043
C 218	10NF-20+80	40	4822 122 30043

POSNR		DESCRIPTION			ORDERING CODE
C	219	10NF-20+80		40	4822 122 30043
C	220	10NF-20+80		40	4822 122 30043
C	221	10NF-20+80		40	4822 122 30043
C	222	10NF-20+80		40	4822 122 30043
C	223	10NF-20+80		40	4822 122 30043
C	226	10NF-20+80		40	4822 122 30043
C	230	100PF	2	100	4822 122 31081
C	231	3,9NF	10	100	4822 122 30098
C	232	22PF	2	100	4822 122 31063
C	234	22PF	2	100	4822 122 31063
C	235	560PF	10	100	4822 122 30126
C	236	10NF-20+80		40	4822 122 30043
C	237	10NF-20+80		40	4822 122 30043
C	238	10NF-20+80		40	4822 122 30043
C	239	10NF-20+80		40	4822 122 30043
C	240	560PF	10	100	4822 122 30126
C	241	10NF-20+80		40	4822 122 30043
C	242	10NF-20+80		40	4822 122 30043
C	243	100NF 10%		250V	4822 121 41161
C	244	10NF-20+80		40	4822 122 30043
C	247	100NF 10%		250V	4822 121 41161
C	248	100NF 10%		250V	4822 121 41161
C	249	100NF 10%		250V	4822 121 41161
C	251	100NF 10%		250V	4822 121 41161
C	301	10NF-20+80		40	4822 122 30043
C	303	470PF	10	100	4822 122 30034
C	304	10NF-20+80		40	4822 122 30043
C	306	22PF	2	100	4822 122 31063
C	307	22NF-20+80		40	4822 122 30103
C	308	10NF-20+80		40	4822 122 30043
C	309	22PF	2	100	4822 122 31063
C	311	10NF-20+80		40	4822 122 30043
C	312	22PF	2	100	4822 122 31063
C	314	22PF	2	100	4822 122 31063
C	315	18PF			5322 125 50051
C	316	100NF 10%		250V	4822 121 41161
C	317	10NF-20+80		40	4822 122 30043
C	318	10NF-20+80		40	4822 122 30043
C	319	10NF-20+80		40	4822 122 30043
C	320	10NF-20+80		40	4822 122 30043
C	322	10NF-20+80		40	4822 122 30043
C	323	10NF-20+80		40	4822 122 30043
C	326	10NF-20+80		40	4822 122 30043
C	330	100PF	2	100	4822 122 31081
C	331	3,9NF	10	100	4822 122 30098
C	332	22PF	2	100	4822 122 31063
C	334	22PF	2	100	4822 122 31063
C	335	560PF	10	100	4822 122 30126
C	336	10NF-20+80		40	4822 122 30043
C	337	10NF-20+80		40	4822 122 30043
C	338	10NF-20+80		40	4822 122 30043
C	340	560PF	10	100	4822 122 30126
C	341	10NF-20+80		40	4822 122 30043
C	342	10NF-20+80		40	4822 122 30043
C	343	100NF 10%		250V	4822 121 41161

POSNR		DESCRIPTION		ORDERING CODE
C	344	10NF-20+80	40	4822 122 30043
C	347	100NF 10%	250V	4822 121 41161
C	348	100NF 10%	250V	4822 121 41161
C	349	100NF 10%	250V	4822 121 41161
C	351	100NF 10%	250V	4822 121 41161
C	400	100PF 2	100	4822 122 31081
C	401	100NF 10%	250V	4822 121 41161
C	403	180PF 10	100	4822 122 30113
C	413	180PF 10	100	4822 122 30113
C	414	10NF-20+80	40	4822 122 30043
C	416	10NF-20+80	40	4822 122 30043
C	417	10NF-20+80	40	4822 122 30043
C	418	10NF-20+80	40	4822 122 30043
C	420	100PF 2	100	4822 122 31081
C	422	10NF-20+80	40	4822 122 30043
C	450	100PF 2	100	4822 122 31081
C	451	100NF 10%	250V	4822 121 41161
C	453	180PF 10	100	4822 122 30113
C	463	180PF 10	100	4822 122 30113
C	464	10NF-20+80	40	4822 122 30043
C	466	10NF-20+80	40	4822 122 30043
C	467	10NF-20+80	40	4822 122 30043
C	468	10NF-20+80	40	4822 122 30043
C	470	100PF 2	100	4822 122 31081
C	471	10NF-20+80	40	4822 122 30043
C	472	10NF-20+80	40	4822 122 30043
C	502	10NF-20+80	40	4822 122 30043
C	503	10PF 2	100	4822 122 31054
C	505	5,6PF 0,25PF	100	4822 122 31047
C	506	22PF 2	100	4822 122 31063
C	507	10PF 2	100	4822 122 31054
C	508	22PF 2	100	4822 122 31063
C	509	10NF-20+80	40	4822 122 30043
C	511	10NF-20+80	40	4822 122 30043
C	512	1PF 0,25PF	100	4822 122 30104
C	513	1PF 0,25PF	100	4822 122 30104
C	514	10NF-20+80	40	4822 122 30043
C	515	33UF-10+50	16	4822 124 20688
C	516	10NF-20+80	40	4822 122 30043
C	517	10NF-20+80	40	4822 122 30043
C	518	10PF 2	100	4822 122 31054
C	601	10NF-20+80	40	4822 122 30043
C	602	5,6PF 0,25PF	100	4822 122 31047
C	603	10NF-20+80	40	4822 122 30043
C	604	100NF 10%	250V	4822 121 41161
C	605	68UF-10+50	16	4822 124 20689
C	606	5,6PF 0,25PF	100	4822 122 31047
C	608	10NF-20+80	40	4822 122 30043
C	609	10NF-20+80	40	4822 122 30043
C	611	100NF 10%	250V	4822 121 41161
C	615	15PF 2	100	4822 122 31058
C	616	18PF		5322 125 50051
C	617	180PF 10	100	4822 122 30113
C	618	180PF 10	100	4822 122 30113
C	620	10NF-20+80	40	4822 122 30043
C	621	10NF-20+80	40	4822 122 30043
C	622	10NF-20+80	40	4822 122 30043
C	623	10NF-20+80	40	4822 122 30043
C	625	10NF–20+80%	40V	4822 121 41161
C	626	4,7NF 10	100	4822 122 30128
C	628	22PF 2	100	4822 122 31063
C	629	22PF 2	100	4822 122 31063
C	700	2,2PF 0,25PF	500	4822 122 31186
C	701	8,2PF 0,25PF	500	4822 122 31194
C	702	82PF 2	100	5322 122 34094

POSNR	DESCRIPTION		ORDERING CODE
C 703	100PF 10	500	4822 122 31211
C 704	22NF 10%	250V	4822 121 40407
C 705	100NF 10%	250V	4822 121 41161
C 706	10NF-20+80	40	4822 122 30043
C 707	470PF 10	100	4822 122 30034
C 708	10NF-20+80	40	4822 122 30043
C 709	10NF-20+80	40	4822 122 30043
C 710	3,9PF 0,25PF	500	4822 122 31217
C 711	10NF-20+80	40	4822 122 30043
C 712	10NF-20+80	40	4822 122 30043
C 713	82PF 2	100	5322 122 34094
C 714	1,8PF 0,25PF	100	4822 122 31407
C 718	68UF-10+50	16	4822 124 20689
C 801	10NF-20+80	40	4822 122 30043
C 802	10NF-20+80	40	4822 122 30043
C 803	10NF-20+80	40	4822 122 30043
C 804	22PF 2	100	4822 122 31063
C 805	1NF-20+80	40	4822 122 30027
C 807	100PF 2	100	4822 122 31316
C 808	10NF-20+80	40	4822 122 30043
C 809	100NF 10%	250V	4822 121 41161
C 811	10NF-20+80	40	4822 122 30043
C 812	100PF 2	100	4822 122 31316
C 813	10NF-20+80	40	4822 122 30043
C 814	100PF 2	100	4822 122 31316
C 817	100PF 2	100	4822 122 31316
C 822	10NF-20+80	40	4822 122 30043
C 823	10UF-10+50	25	4822 124 20697
C 824	12PF 2	100	4822 122 31056
C 826	12PF 2	100	4822 122 31056
C 827	220PF 10	100	4822 122 30094
C 829	10NF-20+80	40	4822 122 30043
C 830	10NF-20+50	100	4822 122 31414
C 832	12PF 2	100	4822 122 31056
C 833	12PF 2	100	4822 122 31056
C 834	100NF 20%	100V	4822 121 40522
C 836	10PF 2	100	4822 122 31054
C 837	10PF 2	100	4822 122 31054
C 838	10NF-20+80	40	4822 122 30043
C 841	10NF-20+80	40	4822 122 30043
C 842	10UF-10+50	25	4822 124 20697
C 843	10NF-20+80	40	4822 122 30043
C 844	10NF-20+80	40	4822 122 30043
C 846	10NF-20+80	40	4822 122 30043
C 847	10NF-20+80	40	4822 122 30043
C 848	10UF-10+50	25	4822 124 20697
C 849	10NF-20+80	40	4822 122 30043
C 851	10NF-20+80	40	4822 122 30043
C 852	10UF-10+50	25	4822 124 20697
C 853	10NF-20+80	40	4822 122 30043
C 854	10NF-20+80	40	4822 122 30043
C 856	10UF-10+50	25	4822 124 20697
C 857	10NF-20+80	40	4822 122 30043
C 900	22PF 2	100	4822 122 31063
C 901	10UF-10+50	25	4822 124 20697

POSNR	DESCRIPTION		ORDERING CODE
C 903	10NF-20+80	40	4822 122 30043
C 904	10UF-10+50	25	4822 124 20697
C 907	10NF-20+80	40	4822 122 30043
C 908	10NF-20+80	40	4822 122 30043
C 909	10NF-20+80	40	4822 122 30043
C 911	10NF-20+80	40	4822 122 30043
C 912	4.7UF 10%	100V	5322 121 40224
C 913	47NF 1%	63V	5322 121 54108
C 914	4.3NF 1%	63V	5322 121 54062
C 915	100PF 2	100	4822 122 31316
C 916	60PF		5322 125 54003
C 917	392PF 1%	630V	5322 121 54228
C 918	100NF 10%	250V	4822 121 41161
C 919	470PF 10	100	4822 122 30034
C 921	6,8UF-10+50	40	4822 124 20707
C 922	10UF-10+50	25	4822 124 20697
C 923	68UF-10+50	16	4822 124 20689
C 924	10NF-20+80	40	4822 122 30043
C 925	10PF 2	100	4822 122 31054
C 926	470NF 10%	100V	4822 121 40438
C 927	4,7NF 10	100	4822 122 30128
C 928	1,8NF 10	100	4822 122 30048
C 930	220PF 10	100	4822 122 30094
C 931	100NF 10%	250V	4822 121 41161
C 932	4,7PF 0,25PF	500	4822 122 31189
C 1100	3,9PF 0,25PF	500	4822 122 31217
C 1101	100PF 10	500	4822 122 31211
C 1102	22NF 10%	250V	4822 121 40407
C 1103	10NF-20+80	40	4822 122 30043
C 1104	470PF 10	100	4822 122 30034
C 1106	3,9PF 0,25PF	500	4822 122 31217
C 1201	100PF 2	100	4822 122 31316
C 1202	10NF-20+80	40	4822 122 30043
C 1204	10NF-20+50	100	4822 122 31414
C 1205	1NF-20+80	40	4822 122 30027
C 1206	10NF-20+80	40	4822 122 30043
C 1207	10NF-20+80	40	4822 122 30043
C 1208	22PF 2	100	4822 122 31063
C 1212	10NF-20+80	40	4822 122 30043
C 1213	100PF 2	100	4822 122 31316
C 1214	100PF 2	100	4822 122 31316
C 1216	10NF-20+80	40	4822 122 30043
C 1217	10UF-10+50	25	4822 124 20697
C 1218	10NF-20+80	40	4822 122 30043
C 1219	12PF 2	100	4822 122 31056
C 1220	47UF-10+50	10	4822 124 20678
C 1221	220PF 10	100	4822 122 30094
C 1223	330PF 10	100	4822 122 30055
C 1224	12PF 2	100	4822 122 31056
C 1226	12PF 2	100	4822 122 31056
C 1228	12PF 2	100	4822 122 31056
C 1229	10PF 2	100	4822 122 31054
C 1231	12PF 2	100	4822 122 31056
C 1232	10PF 2	100	4822 122 31054
C 1234	10NF-20+80	40	4822 122 30043
C 1236	10NF-20+80	40	4822 122 30043
C 1237	10NF-20+80	40	4822 122 30043
C 1238	10NF-20+80	40	4822 122 30043
C 1239	10NF-20+80	40	4822 122 30043
C 1301	10NF-20+80	40	4822 122 30043
C 1302	10NF-20+80	40	4822 122 30043
C 1303	10NF-20+80	40	4822 122 30043
C 1304	10NF-20+80	40	4822 122 30043
C 1305	22PF 2	100	4822 122 31063
C 1306	10NF-20+80	40	4822 122 30043

POSNR	DESCRIPTION		ORDERING CODE
C 1307	4.7UF 10%	100V	5322 121 40224
C 1308	47NF 1%	63V	5322 121 54108
C 1309	4.3NF 1%	63V	5322 121 54062
C 1311	60PF		5322 125 54003
C 1312	392PF 1%	630V	5322 121 54228
C 1313	100NF 10%	250V	4822 121 41161
C 1314	470PF 10	100	4822 122 30034
C 1315	100PF 2	100	4822 122 31316
C 1316	10NF-20+80	40	4822 122 30043
C 1317	10UF-10+50	25	4822 124 20697
C 1318	6,8UF-10+50	40	4822 124 20707
C 1319	10NF-20+80	40	4822 122 30043
C 1320	10NF-20+80	40	4822 122 30043
C 1321	100PF 2	100	4822 122 31316
C 1322	10NF-20+80	40	4822 122 30043
C 1323	10UF-10+50	25	4822 124 20697
C 1324	10PF 2	100	5322 122 34143
C 1325	220PF 2	100	4822 122 31222
C 1326	47UF-10+50	10	4822 124 20678
C 1501	3,9PF 0,25PF	100	5322 122 34107
C 1502	22NF-20+80	40	4822 122 30103
C 1503	270PF 2	100	4822 122 31335
C 1504	22NF-20+80	40	4822 122 30103
C 1505	56PF 2	100	4822 122 31521
C 1550	100NF 10%	250V	4822 121 41161
C 1551	100NF 10%	250V	4822 121 41161
C 1552	100NF 10%	250V	4822 121 41161
C 1553	2,7NF 10	100	4822 122 30057
C 1554	2,7NF 10	100	4822 122 30057
C 1557	100NF 10%	250V	4822 121 41161
C 1559	2,7NF 10	100	4822 122 30057
C 1561	100NF 10%	250V	4822 121 41161
C 1562	100NF 10%	250V	4822 121 41161
C 1563	2,7NF 10	100	4822 122 30057
C 1564	2,7NF 10	100	4822 122 30057
C 1567	100NF 10%	250V	4822 121 41161
C 1569	2,7NF 10	100	4822 122 30057
C 1601	82PF 2	100	4822 122 31243
C 1602	100PF 2	100	4822 122 31316
C 1603	22PF 2	100	4822 122 31063
C 1604	10NF-20+80	40	4822 122 30043
C 1605	56PF 2	100	4822 122 31074
C 1606	10NF-20+80	40	4822 122 30043
C 1607	100PF 2	100	4822 122 31316
C 1608	10NF-20+80	40	4822 122 30043
C 1609	220UF-10+50	10	4822 124 20681
C 1611	10NF-20+80	40	4822 122 30043
C 1613	470PF 10	100	4822 122 30034
C 1614	470PF 10	100	4822 122 30034
C 1616	10NF-20+80	40	4822 122 30043
C 1617	10NF-20+80	40	4822 122 30043
C 1651	68UF-10+50	6,3	4822 124 20671
C 1652	33UF-10+50	16	4822 124 20688
C 1653	68UF-10+50	16	4822 124 20689
C 1654	68UF-10+50	6,3	4822 124 20671

POSNR	DESCRIPTION		ORDERING CODE
C 1655	150UF-10+50	6,3	4822 124 20672
C 1656	33UF-10+50	16	4822 124 20688
C 1657	33UF-10+50	16	4822 124 20688
C 1658	68UF-10+50	6,3	4822 124 20671
C 1659	33UF-10+50	16	4822 124 20688
C 1661	68UF-10+50	16	4822 124 20689
C 1662	33UF-10+50	16	4822 124 20688
C 1663	33UF-10+50	16	4822 124 20688
C 1664	68UF-10+50	6,3	4822 124 20671
C 1665	150UF-10+50	6,3	4822 124 20672
C 1701	10NF	630V	4822 121 41134
C 1702	10UF-10+50	63	4822 124 20728
C 1703	3,5PF		5322 125 50048
C 1704	1PF 0,25PF	100	4822 122 30104
C 1706	8,2PF 0,25PF	500	4822 122 31194
C 1707	330PF 10	500	4822 122 31165
C 1801	220NF 10%	250V	5322 121 44142
C 1802	220UF-10+50	350	5322 124 44007
C 1803	220UF-10+50	350	5322 124 44007
C 1804	47NF 10%	630V	4822 121 40342
C 1806	270PF 10%	2KV	5322 122 54024
C 1807	30.1NF 2%	500V	5322 121 44248
C 1808	30.1NF 2%	500V	5322 121 44248
C 1809	22NF-20+80	40	4822 122 30103
C 1811	22NF-20+80	40	4822 122 30103
C 1812	3.3NF 1%	160V	5322 121 54049
C 1813	22NF-20+80	40	4822 122 30103
C 1814	10UF-20+20	16	5322 124 24089
C 1816	10UF-20+20	16	5322 124 24089
C 1817	100NF 10%	250V	4822 121 41161
C 1818	10UF-20+20	16	5322 124 24089
C 1819	22UF-20+20	25	5322 124 24099
C 1821	22UF-20+20	25	5322 124 24099
C 1826	560PF 10	500	4822 122 31166
C 1828	220UF-20+20	6,3	5322 124 24212
C 1829	220UF-20+20	6,3	5322 124 24212
C 1831	100UF-20+20	16	5322 124 24155
C 1832	100UF-20+20	16	5322 124 24155
C 1833	2,2UF 10%	100V	4822 121 40456
C 1834	2,2UF 10%	100V	4822 121 40456
C 1836	100NF 10%	250V	4822 121 41161
C 1837	33NF 10%	400V	4822 121 40411
C 1838	10NF	630V	4822 121 41134
C 1839	10UF-20+20	16	5322 124 24089
C 1841	100NF 10%	250V	4822 121 41161
C 1842	100PF 2	100	4822 122 31316
C 1851	470PF 20%	4KV	5322 122 54004
C 1852	470PF 20%	4KV	5322 122 54004
C 1853	470PF 20%	4KV	5322 122 54004
C 1854	470PF 20%	4KV	5322 122 54004
C 1856	600PF	9KV	5322 122 24001
C 1876	22NF 10%	250V	4822 121 40407
C 1877	22NF 10%	250V	4822 121 40407
C 1878	100NF 10%	250V	4822 121 41161
C 1879	100NF 10%	250V	4822 121 41161
C 1881	47NF 10%	400V	4822 121 40239
C 1882	100NF 10%	250V	4822 121 41161
C 1901	10UF-10+50	63	4822 124 20728
C 1902	680NF 10%	100V	5322 121 40233
C 1903	20NF 1%	63V	4822 121 50611
C 1904	10UF-10+50	63	4822 124 20728
C 2001	10NF-20+80	40	4822 122 30043
C 2002	10UF-10+50	63	4822 124 20728
C 2003	8,2PF 0,25PF	100	4822 122 31052
C 2004	22NF-20+80	40	4822 122 30103

POSNR	DESCRIPTION			ORDERING CODE
C 2005	470PF	10	100	4822 122 30034
C 2006	8,2PF	0,25PF	100	4822 122 31052
C 2007	330PF	10	100	4822 122 30055
C 2008	100NF	10%	250V	4822 121 41161
C 2009	330PF	10	100	4822 122 30055
C 2013	2,2NF	10	500	4822 122 31116
C 2016	10NF-20+80		40	4822 122 30043
C 2018	100NF	10%	250V	4822 121 41161
C 2021	100NF	10%	250V	4822 121 41161
C 2026	2,2NF	10	500	4822 122 31116
C 2027	10NF-20+80		40	4822 122 30043
C 2031	100NF	10%	250V	4822 121 41161
C 2032	1.8NF	1%	250V	5322 121 54087
C 2033	3,3NF	10	100	4822 122 30099
C 2051	100NF	10%	250V	4822 121 41161
C 2052	100NF	10%	250V	4822 121 41161
C 2053	10NF-20+80		40	4822 122 30043
C 2054	100NF	10%	250V	4822 121 41161
C 2055	4,7NF-20+50		3K	5322 122 50001
C 2056	2,2NF	10	100	4822 122 30114
C 2057	2,2NF	10	100	4822 122 30114
C 2062	100NF	10%	250V	4822 121 41161
C 2064	10UF-10+50		25	4822 124 20697
C 2066	10UF-10+50		25	4822 124 20697
C 2067	10UF-10+50		25	4822 124 20697
C 2076	1NF-20+50		4K	4822 122 31175
C 2077	4,7NF-20+50		4K	5322 122 34112
C 2078	100PF	10	500	4822 122 31211
C 2079	4,7NF-20+50		4K	5322 122 34112
C 2080	4,7NF-20+50		4K	5322 122 34112
C 2081	4,7NF-20+50		4K	5322 122 34112
C 2082	4,7NF-20+50		4K	5322 122 34112
C 2083	1NF-20+50		4K	4822 122 31175
C 2084	1NF-20+50		4K	4822 122 31175
C 2086	4,7NF-20+50		3K	5322 122 50001
C 2087	4,7NF-20+50		3K	5322 122 50001
C 2088	4,7NF-20+50		3K	5322 122 50001
C 2089	220PF	20%	5KV	5322 122 54007
C 2101	100PF	2	100	4822 122 31316
C 2102	390PF	2	100	4822 122 31426
C 2103	1NF	10	100	4822 122 30027
C 2202	100NF	10%	250V	4822 121 41161
C 2203	100NF	10%	250V	4822 121 41161
C 2208	100NF	10%	250V	4822 121 41161
C 2209	100NF	10%	250V	4822 121 41161
C 2212	100NF	10%	250V	4822 121 41161
C 2213	100NF	10%	250V	4822 121 41161
C 2214	100NF	10%	250V	4822 121 41161
C 2216	100NF	10%	250V	4822 121 41161
C 2217	10UF-10+50		63	4822 124 20728
C 2218	10NF-20+80		40	4822 122 30043
C 2219	100NF	10%	250V	4822 121 41161
C 2222	22NF	10%	250V	4822 121 40407
C 2223	100NF	10%	250V	4822 121 41161
C 2224	100NF	10%	250V	4822 121 41161

POSNR	DESCRIPTION		ORDERING CODE
C 2226	100NF 10%	250V	4822 121 41161
C 2227	1,8NF 10	100	4822 122 30048
C 2228	10NF	630V	4822 121 41134
C 2229	100NF 10%	250V	4822 121 41161
C 2231	100NF 10%	250V	4822 121 41161
C 2232	1,8NF 10	100	4822 122 30048
C 2238	100NF 10%	250V	4822 121 41161
C 2239	100NF 10%	250V	4822 121 41161
C 2244	100NF 10%	250V	4822 121 41161
C 2401	100NF 10%	250V	4822 121 41161
C 2402	100NF 10%	250V	4822 121 41161
C 2403	100PF 2	100	4822 122 31316
C 2404	4,7NF 10	100	4822 122 30128
C 2405	2,2PF 0,25PF	100	4822 122 31036
C 2406	10NF-20+80	40	4822 122 30043
C 2407	10NF-20+80	40	4822 122 30043
C 2408	10NF-20+80	40	4822 122 30043
C 2409	100NF 10%	250V	4822 121 41161
C 2410	100PF 2	100	4822 122 31316
C 2411	4,7NF 10	100	4822 122 30128
C 2412	6,8UF-10+50	63	4822 124 20727
C 2413	100NF 10%	250V	4822 121 41161
C 2414	100NF 10%	250V	4822 121 41161
C 2415	10UF-10+50	63	4822 124 20728
C 2416	10NF-20+80	40	4822 122 30043
C 2417	10NF	630V	4822 121 41134
C 2418	100NF 10%	250V	4822 121 41161
C 2419	100NF 10%	250V	4822 121 41161
C 2421	100PF 2	100	4822 122 31316
C 2422	15UF-10+50	40	4822 124 20709
C 2424	100NF 10%	250V	4822 121 41161
C 2426	100NF 10%	250V	4822 121 41161
C 2427	2,2UF-10+50	63	4822 124 20724
C 2429	100NF 10%	250V	4822 121 41161

RESISTORS

POSNR		DESCRIPTION			ORDERING CODE
R	1	47K +47K	LIN	0,1W	5322 103 50002
R	2	47K +47K	LIN	0,1W	5322 102 40057
R	3	10K	20	0.1W	5322 101 44039
R	4	10K	20	0.1W	5322 101 44039
R	5	10K	20	0.1W	5322 101 44039
R	6	4,7K	20	0.1W	5322 101 24129
R	7	10K	20	0.1W	5322 101 44039
R	8	10K	20	0.1W	5322 101 44038
R	9	10K	20	0.1W	5322 101 44038
R	10	10K	20	0.1W	5322 101 44023
R	11	10K	20	0.1W	5322 101 44023
R	12	10K	20	0.1W	5322 101 24148
R	13	10K	20	0.1W	5322 101 24148
R	14	25K	20		5322 101 24055
R	15	22K	20	0.1W	4822 101 20417
R	16	10K	20	0.1W	5322 102 44007
R	17	10K	20	0.1W	5322 101 24156
R	18	4K7+4K7	LIN	0,1W	5322 102 34019
R	19	10K	20	0.1W	4822 101 20441
R	20	10K	20	0.1W	4822 101 20441
R	100	10	1	MR25	5322 116 50452
R	101	1,8M	5	0,125W	5322 111 44121
R	102	10	5	0.125W	5322 116 64045
R	103	1K	5	0.125W	4822 116 51123
R	104	900K	0,5	SPEC	5322 116 55152
R	105	22	5	0.125W	5322 116 64108
R	106	111K	0,5	MR25	5322 116 55316
R	107	47	5	0.125W	5322 116 64049
R	108	1K	5	0.125W	4822 116 51123
R	109	992K	0,5	SPEC	5322 116 55153
R	110	71,5	1	MR16	5322 116 55409
R	111	10,1K	0,5	MR25	5322 116 55285
R	112	47	5	0.125W	5322 116 64049
R	113	15	5	0.125W	5322 116 64051
R	114	100M	5	0,125W	5322 111 30376
R	116	15	5	0.125W	5322 116 64051
R	117	51,1	1	MR25	5322 116 54442
R	118	6,81K	1	MR25	5322 116 54012
R	119	12,1K	1	MR25	5322 116 50572
R	121	750	1	MR25	4822 116 51234
R	122	750K	1	MR30	5322 116 54335
R	123	255K	1	MR25	5322 116 54735
R	124	1K	20	0.75W	5322 100 10143
R	126	221K	1	MR25	4822 116 51272
R	127	10M	5	VR37	4822 110 42214
R	128	33M	5	VR37	4822 110 42227
R	129	10K	20	0.75W	5322 100 10141
R	131	5,11K	1	MR25	5322 116 54595
R	132	47K	20	0.75W	5322 101 14056
R	133	100K	1	MR25	4822 116 51268
R	134	301K	1	MR25	5322 116 54743
R	141	274	1	MR25	5322 116 54504
R	150	10	1	MR25	5322 116 50452
R	151	1,8M	5	0,125W	5322 111 44121
R	152	10	5	0.125W	5322 116 64045
R	153	1K	5	0.125W	4822 116 51123
R	154	900K	0,5	SPEC	5322 116 55152
R	155	22	5	0.125W	5322 116 64108
R	156	111K	0,5	MR25	5322 116 55316
R	157	47	5	0.125W	5322 116 64049
R	158	1K	5	0.125W	4822 116 51123
R	159	992K	0,5	SPEC	5322 116 55153

POSNR		DESCRIPTION			ORDERING CODE	
R	160	71,5	1	MR16	5322 116 55409	
R	161	10,1K	0,5	MR25	5322 116 55285	
R	162	47	5	0.125W	5322 116 64049	
R	163	15	5	0.125W	5322 116 64051	
R	164	100M	5	0,125W	5322 111 30376	
R	166	15	5	0.125W	5322 116 64051	
R	167	51,1	1	MR25	5322 116 54442	
R	168	6,81K	1	MR25	5322 116 54012	
R	169	12,1K	1	MR25	5322 116 50572	
R	171	750	1	MR25	4822 116 51234	
R	172	750K	1	MR30	5322 116 54335	
R	173	255K	1	MR25	5322 116 54735	
R	174	1K	20	0.75W	5322 100 10143	
R	176	221K	1	MR25	4822 116 51272	
R	177	10M	5	VR37	4822 110 42214	
R	178	33M	5	VR37	4822 110 42227	
R	179	10K	20	0.75W	5322 100 10141	
R	181	5,11K	1	MR25	5322 116 54595	
R	182	47K	20	0.75W	5322 101 14056	
R	183	100K	1	MR25	4822 116 51268	
R	184	301K	1	MR25	5322 116 54743	
R	191	274	1	MR25	5322 116 54504	
R	201	536	1	MR25	5322 116 50621	
R	202	30,1	1	MR25	5322 116 50904	
R	203	30,1	1	MR25	5322 116 50904	
R	206	51,1	1	MR25	5322 116 54442	
R	207	160	5	0.125W	5322 116 64071	
R	208	100	1	MR25	5322 116 54469	
R	209	5,9K	1	MR25	5322 116 50583	
R	212	5,11K	1	MR25	5322 116 54595	
R	213	160	5	0.125W	5322 116 64071	
R	214	100	1	MR25	5322 116 54469	
R	215	100	1	MR25	5322 116 54469	
R	216	10K	20	0.75W	5322 100 10141	
R	217	10K	1	MR25	4822 116 51253	
R	218	249	1	MR25	5322 116 54499	
R	219	100	1	MR25	5322 116 54469	
R	221	249	1	MR25	5322 116 54499	
R	222	100	1	MR25	5322 116 54469	
R	223	562	1	MR25	5322 116 54009	
R	224	6,19K	1	MR25	5322 116 50608	
R	225	1K	1	MR25	5322 116 54549	
R	226	16,2K	1	MR25	5322 116 55361	
R	227	316	1	MR25	5322 116 54511	
R	228	2,74K	1	MR25	5322 116 50636	
R	229	3,48K	1	MR25	5322 116 54585	
R	231	5,36K	1	MR25	5322 116 54597	
R	232	100	1	MR25	5322 116 54469	
R	233	56,2	0,1	MR24E	5322 116 55601	
R	234	59	0,1	MR24E	5322 116 54364	
R	235	9,09	1	MR25	5322 116 50863	
R	236	237	0,1	MR24E	5322 116 54995	
R	237	56,2	0,1	MR24E	5322 116 55601	
R	238	59	0,1	MR24E	5322 116 54364	
R	239	237	0,1	MR24E	5322 116 54995	

POSNR	DESCRIPTION			ORDERING CODE
R 240	9,09	1	MR25	5322 116 50863
R 241	100K	1	MR25	4822 116 51268
R 242	100K	1	MR25	4822 116 51268
R 243	3,48K	1	MR25	5322 116 54585
R 244	100	20	0.75W	5322 100 10138
R 247	10	1	MR25	5322 116 50452
R 248	20,5	1	MR25	5322 116 50678
R 249	511	1	MR25	4822 116 51282
R 251	20,5	1	MR25	5322 116 50678
R 252	10	1	MR25	5322 116 50452
R 253	2,2K	20	0.75W	5322 100 10144
R 254	4,7K	20	0.75W	5322 100 10139
R 256	1K	1	MR25	5322 116 54549
R 257	4,7K	20	0.75W	5322 100 10139
R 258	5,9K	1	MR25	5322 116 50583
R 259	10K	20	0.75W	5322 100 10141
R 261	100	1	MR25	5322 116 54469
R 262	10	1	MR25	5322 116 50452
R 263	10	1	MR25	5322 116 50452
R 264	100	1	MR25	5322 116 54469
R 266	100	1	MR25	5322 116 54469
R 267	100	1	MR25	5322 116 54469
R 268	4,64K	1	MR25	5322 116 50484
R 269	4,64K	1	MR25	5322 116 50484
R 271	1K	1	MR25	5322 116 54549
R 272	12,1K	1	MR25	5322 116 50572
R 273	140	1	MR25	5322 116 54484
R 274	100	1	MR25	5322 116 54469
R 276	536	1	MR25	5322 116 50621
R 277	1,33K	1	MR25	5322 116 54561
R 278	681	1	MR25	4822 116 51233
R 279	10	1	MR25	5322 116 50452
R 281	10	1	MR25	5322 116 50452
R 282	10	1	MR25	5322 116 50452
R 283	100	1	MR25	5322 116 54469
R 284	4,64K	1	MR25	5322 116 50484
R 286	5,11K	1	MR25	5322 116 54595
R 287	5,11K	1	MR25	5322 116 54595
R 288	100	1	MR25	5322 116 54469
R 301	536	1	MR25	5322 116 50621
R 302	30,1	1	MR25	5322 116 50904
R 303	30,1	1	MR25	5322 116 50904
R 306	51,1	1	MR25	5322 116 54442
R 307	160	5	0.125W	5322 116 64071
R 308	100	1	MR25	5322 116 54469
R 309	5,9K	1	MR25	5322 116 50583
R 311	10K	20	0.75W	5322 100 10141
R 312	5,11K	1	MR25	5322 116 54595
R 313	160	5	0.125W	5322 116 64071
R 314	100	1	MR25	5322 116 54469
R 315	100	1	MR25	5322 116 54469
R 316	10K	20	0.75W	5322 100 10141
R 317	10K	1	MR25	4822 116 51253
R 318	249	1	MR25	5322 116 54499
R 319	100	1	MR25	5322 116 54469
R 321	249	1	MR25	5322 116 54499
R 322	100	1	MR25	5322 116 54469
R 323	562	1	MR25	5322 116 54009
R 324	6,19K	1	MR25	5322 116 50608
R 325	1K	1	MR25	5322 116 54549
R 326	16,2K	1	MR25	5322 116 55361
R 327	316	1	MR25	5322 116 54511
R 328	2,74K	1	MR25	5322 116 50636
R 329	3,48K	1	MR25	5322 116 54585
R 331	5,36K	1	MR25	5322 116 54597
R 332	100	1	MR25	5322 116 54469

POSNR		DESCRIPTION			ORDERING CODE
R	333	56,2	0,1	MR24E	5322 116 55601
R	334	59	0,1	MR24E	5322 116 54364
R	335	9,09	1	MR25	5322 116 50863
R	336	237	0,1	MR24E	5322 116 54995
R	337	56,2	0,1	MR24E	5322 116 55601
R	338	59	0,1	MR24E	5322 116 54364
R	339	237	0,1	MR24E	5322 116 54995
R	340	9,09	1	MR25	5322 116 50863
R	341	100K	1	MR25	4822 116 51268
R	342	100K	1	MR25	4822 116 51268
R	343	3,48K	1	MR25	5322 116 54585
R	344	100	20	0.75W	5322 100 10138
R	347	10	1	MR25	5322 116 50452
R	348	20,5	1	MR25	5322 116 50678
R	349	511	1	MR25	4822 116 51282
R	351	20,5	1	MR25	5322 116 50678
R	352	10	1	MR25	5322 116 50452
R	353	2,2K	20	0.75W	5322 100 10144
R	354	4,7K	20	0.75W	5322 100 10139
R	356	1K	1	MR25	5322 116 54549
R	357	4,7K	20	0.75W	5322 100 10139
R	358	5,9K	1	MR25	5322 116 50583
R	359	10K	20	0.75W	5322 100 10141
R	361	100	1	MR25	5322 116 54469
R	362	10	1	MR25	5322 116 50452
R	363	10	1	MR25	5322 116 50452
R	364	100	1	MR25	5322 116 54469
R	366	100	1	MR25	5322 116 54469
R	367	100	1	MR25	5322 116 54469
R	368	4,64K	1	MR25	5322 116 50484
R	369	4,64K	1	MR25	5322 116 50484
R	371	1K	1	MR25	5322 116 54549
R	372	12,1K	1	MR25	5322 116 50572
R	373	681	1	MR25	4822 116 51233
R	374	100	1	MR25	5322 116 54469
R	376	536	1	MR25	5322 116 50621
R	377	1,33K	1	MR25	5322 116 54561
R	378	140	1	MR25	5322 116 54484
R	379	10	1	MR25	5322 116 50452
R	381	10	1	MR25	5322 116 50452
R	382	10	1	MR25	5322 116 50452
R	383	100	1	MR25	5322 116 54469
R	384	4,64K	1	MR25	5322 116 50484
R	386	5,11K	1	MR25	5322 116 54595
R	387	5,11K	1	MR25	5322 116 54595
R	388	100	1	MR25	5322 116 54469
R	401	3,48K	1	MR25	5322 116 54585
R	402	249	1	MR25	5322 116 54499
R	403	3,48K	1	MR25	5322 116 54585
R	404	100	1	MR25	5322 116 54469
R	406	30,1	1	MR25	5322 116 50904
R	407	30,1	1	MR25	5322 116 50904
R	408	4,64K	1	MR25	5322 116 50484
R	409	4,7K	20	0.75W	5322 100 10139
R	411	2,2K	20	0.75W	5322 100 10144

POSNR	DESCRIPTION			ORDERING CODE
R 412	30,1	1	MR25	5322 116 50904
R 413	220	20	0.75W	5322 100 10133
R 416	100	20	0.75W	5322 100 10138
R 418	365	1	MR25	5322 116 54516
R 419	178	1	MR25	5322 116 54492
R 421	10	1	MR25	5322 116 50452
R 422	10	1	MR25	5322 116 50452
R 424	365	1	MR25	5322 116 54516
R 426	100K	1	MR25	4822 116 51268
R 427	5,9K	1	MR25	5322 116 50583
R 428	10K	20	0.75W	5322 100 10141
R 429	5,9K	1	MR25	5322 116 50583
R 431	10K	20	0.75W	5322 100 10141
R 432	100K	1	MR25	4822 116 51268
R 433	100	1	MR25	5322 116 54469
R 434	147	1	MR25	5322 116 50766
R 436	8,25K	1	MR25	5322 116 54558
R 437	2,61K	1	MR25	5322 116 50671
R 438	2,05K	1	MR25	5322 116 50664
R 439	12,1K	1	MR25	5322 116 50572
R 441	10K	1	MR25	4822 116 51253
R 442	2,61K	1	MR25	5322 116 50671
R 443	15,4K	1	MR25	5322 116 50479
R 451	3,48K	1	MR25	5322 116 54585
R 452	249	1	MR25	5322 116 54499
R 453	3,48K	1	MR25	5322 116 54585
R 454	100	1	MR25	5322 116 54469
R 456	30,1	1	MR25	5322 116 50904
R 457	30,1	1	MR25	5322 116 50904
R 458	4,64K	1	MR25	5322 116 50484
R 459	4,7K	20	0.75W	5322 100 10139
R 461	2,2K	20	0.75W	5322 100 10144
R 462	30,1	1	MR25	5322 116 50904
R 463	220	20	0.75W	5322 100 10133
R 466	100	20	0.75W	5322 100 10138
R 468	365	1	MR25	5322 116 54516
R 469	178	1	MR25	5322 116 54492
R 471	10	1	MR25	5322 116 50452
R 472	10	1	MR25	5322 116 50452
R 474	365	1	MR25	5322 116 54516
R 476	100K	1	MR25	4822 116 51268
R 477	5,9K	1	MR25	5322 116 50583
R 478	10K	20	0.75W	5322 100 10141
R 479	5,9K	1	MR25	5322 116 50583
R 481	10K	20	0.75W	5322 100 10141
R 482	100K	1	MR25	4822 116 51268
R 483	100	1	MR25	5322 116 54469
R 484	147	1	MR25	5322 116 50766
R 486	8,25K	1	MR25	5322 116 54558
R 487	2,61K	1	MR25	5322 116 50671
R 488	15,4K	1	MR25	5322 116 50479
R 489	10K	1	MR25	4822 116 51253
R 491	100	1	MR25	5322 116 54469
R 493	2,61K	1	MR25	5322 116 50671
R 494	100	1	MR25	5322 116 54469
R 500	10K	20	0.75W	5322 100 10141
R 501	140	1	MR25	5322 116 54484
R 502	147	1	MR25	5322 116 50766
R 503	48,7	1	MR25	5322 116 50511
R 504	274	1	MR25	5322 116 54504
R 505	1,54K	1	MR25	5322 116 50586
R 506	249	1	MR25	5322 116 54499
R 507	140	1	MR25	5322 116 54484
R 508	140	1	MR25	5322 116 54484
R 509	402	1	MR25	5322 116 54519

POSNR		DESCRIPTION			ORDERING CODE
R	510	10	1	MR25	5322 116 50452
R	511	51,1	1	MR25	5322 116 54442
R	512	48,7	1	MR25	5322 116 50511
R	513	274	1	MR25	5322 116 54504
R	514	249	1	MR25	5322 116 54499
R	515	10	1	MR25	5322 116 50452
R	516	59	1	MR25	5322 116 54448
R	517	3,01K	1	MR25	4822 116 51246
R	518	2,74K	1	MR25	5322 116 50636
R	519	100	20	0.75W	5322 100 10138
R	521	536	1	MR25	5322 116 50621
R	522	274	1	MR25	5322 116 54504
R	523	536	1	MR25	5322 116 50621
R	524	59	1	MR25	5322 116 54448
R	526	5,9K	1	MR25	5322 116 50583
R	527	10K	20	0.75W	5322 100 10141
R	528	100	1	MR25	5322 116 54469
R	529	348	1	MR25	5322 116 54515
R	531	10	1	MR25	5322 116 50452
R	534	30,1	1	MR25	5322 116 50904
R	536	442	1	MR25	5322 116 50592
R	537	30,1	1	MR25	5322 116 50904
R	538	10	1	MR25	5322 116 50452
R	541	1K	1	MR25	5322 116 54549
R	541	10	1	MR25	5322 116 50452
R	542	10	1	MR25	5322 116 50452
R	543	100	1	MR25	5322 116 54469
R	544	348	1	MR25	5322 116 54515
R	546	4,64K	1	MR25	5322 116 50484
R	547	100	1	MR25	5322 116 54469
R	548	10	1	MR25	5322 116 50452
R	552	121	1	MR25	5322 116 54426
R	601	715	1	MR25	5322 116 50571
R	602	51,1	1	MR25	5322 116 54442
R	603	205	1	MR25	5322 116 50669
R	604	115	1	MR25	5322 116 54476
R	606	4,22K	1	MR25	5322 116 50729
R	607	100	1	MR25	5322 116 54469
R	608	2,26K	1	MR25	5322 116 50675
R	609	51,1	1	MR25	5322 116 54442
R	610	84,5	0,5	MR30	5322 116 54776
R	611	715	1	MR25	5322 116 50571
R	612	205	1	MR25	5322 116 50669
R	613	115	1	MR25	5322 116 54476
R	614	6,81K	1	MR25	5322 116 54012
R	616	4,64K	1	MR25	5322 116 50484
R	617	348	1	MR25	5322 116 54515
R	618	140	1	MR25	5322 116 54484
R	619	8,25K	1	MR25	5322 116 54558
R	621	100	1	MR25	5322 116 54469
R	622	1,4K	1	MR25	5322 116 54562
R	623	82,5	1	MR25	5322 116 54462
R	624	140	1	MR25	5322 116 54484
R	626	348	1	MR25	5322 116 54515
R	627	4,64K	1	MR25	5322 116 50484

POSNR	DESCRIPTION			ORDERING CODE
R 628	6,81K	1	MR25	5322 116 54012
R 629	1K	1	MR25	5322 116 54549
R 631	316	1	MR25	5322 116 54511
R 632	2,74K	1	MR25	5322 116 50636
R 634	10K	20	0.5W	5322 101 14066
R 636	4,7K	20	0.5W	5322 101 14292
R 637	100	1	MR25	5322 116 54469
R 638	100	1	MR25	5322 116 54469
R 639	10	1	MR25	5322 116 50452
R 640	10K	1	MR25	4822 116 51253
R 641	10	1	MR25	5322 116 50452
R 642	10K	1	MR25	4822 116 51253
R 643	20,5	1	MR25	5322 116 50678
R 644	20,5	1	MR25	5322 116 50678
R 646	10K	20	0.5W	5322 101 14066
R 647	2,74K	1	MR25	5322 116 50636
R 649	1,3K	10	1W	4822 116 30018
R 653	12,1K	1	MR25	5322 116 50572
R 654	10K	20	0,5W	5322 100 10113
R 655	2,05K	1	MR25	5322 116 50664
R 656	2,05K	1	MR25	5322 116 50664
R 657	100	1	MR25	5322 116 54469
R 658	10K	20	0,5W	5322 100 10113
R 659	147	1	MR25	5322 116 50766
R 660	147	1	MR25	5322 116 50766
R 661	100	1	MR25	5322 116 54469
R 701	51,1	1	MR25	5322 116 54442
R 702	909K	1	MR30	5322 116 54408
R 703	110K	1	MR25	5322 116 54701
R 704	301	1	MR25	5322 116 54508
R 706	750K	1	MR30	5322 116 54335
R 707	1K	1	MR25	5322 116 54549
R 708	1K	1	MR25	5322 116 54549
R 709	249K	1	MR25	5322 116 54386
R 711	10M	10	CR25	4822 110 72214
R 712	33,2	1	MR25	5322 116 50527
R 713	6,81K	1	MR25	5322 116 54012
R 714	24,9K	1	MR25	5322 116 54648
R 716	12,1K	1	MR25	5322 116 50572
R 717	100K	1	MR25	4822 116 51268
R 718	24,9K	1	MR25	5322 116 54648
R 719	6,81K	1	MR25	5322 116 54012
R 721	12,1K	1	MR25	5322 116 50572
R 722	24,9K	1	MR25	5322 116 54648
R 723	6,81K	1	MR25	5322 116 54012
R 724	953	1	MR25	5322 116 54547
R 726	100	1	MR25	5322 116 54469
R 727	1,21K	1	MR25	5322 116 54557
R 728	5,11K	1	MR25	5322 116 54595
R 729	10K	20	0,5W	5322 100 10113
R 730	100	1	MR25	5322 116 54469
R 731	187K	1	MR25	5322 116 54723
R 732	6,98K	1	MR25	5322 116 54605
R 733	1,78K	1	MR25	5322 116 50515
R 734	71,5K	1	MR25	5322 116 54685
R 735	5,11K	1	MR25	5322 116 54595
R 736	10K	20	0,5W	5322 100 10113
R 738	200	1	MR25	5322 116 54496
R 742	680	20	0.5W	5322 101 14046
R 744	10	1	MR25	5322 116 50452
R 801	100	1	MR25	5322 116 54469
R 802	750	1	MR25	4822 116 51234
R 803	4,42K	1	MR25	5322 116 50556
R 804	825	1	MR25	5322 116 54541
R 805	100	1	MR25	5322 116 54469

POSNR		DESCRIPTION			ORDERING CODE
R	806	511	1	MR25	4822 116 51282
R	807	750	1	MR25	4822 116 51234
R	808	51,1	1	MR25	5322 116 54442
R	809	46,4	1	MR25	5322 116 50492
R	811	33,2	1	MR25	5322 116 50527
R	812	3,48K	1	MR25	5322 116 54585
R	813	8,25K	1	MR25	5322 116 54558
R	814	33,2	1	MR25	5322 116 50527
R	816	332	1	MR25	4822 116 51226
R	817	51,1	1	MR25	5322 116 54442
R	818	51,1	1	MR25	5322 116 54442
R	819	1,47K	1	MR25	5322 116 50635
R	820	511	1	MR25	4822 116 51282
R	821	1,47K	1	MR25	5322 116 50635
R	822	18,7K	1	MR25	5322 116 50558
R	823	18,7K	1	MR25	5322 116 50558
R	824	100	1	MR25	5322 116 54469
R	825	100	1	MR25	5322 116 54469
R	826	1,47K	1	MR25	5322 116 50635
R	827	1,47K	1	MR25	5322 116 50635
R	828	18,7K	1	MR25	5322 116 50558
R	829	18,7K	1	MR25	5322 116 50558
R	831	100	1	MR25	5322 116 54469
R	832	1,47K	1	MR25	5322 116 50635
R	833	1,47K	1	MR25	5322 116 50635
R	834	18,7K	1	MR25	5322 116 50558
R	835	4,99	1	MR25	5322 116 50568
R	836	18,7K	1	MR25	5322 116 50558
R	837	51,1	1	MR25	5322 116 54442
R	838	51,1	1	MR25	5322 116 54442
R	839	825	1	MR25	5322 116 54541
R	841	205	1	MR25	5322 116 50669
R	842	1K	20	0.75W	5322 100 10143
R	844	33,2	1	MR25	5322 116 50527
R	845	1K	20	0.75W	5322 100 10143
R	846	365	1	MR25	5322 116 54516
R	847	365	1	MR25	5322 116 54516
R	848	909	1	MR25	5322 116 55278
R	849	147	1	MR25	5322 116 50766
R	851	909	1	MR25	5322 116 55278
R	852	22,6	1	MR25	5322 116 50491
R	853	100	1	MR25	5322 116 54469
R	854	95,3	1	MR25	5322 116 50569
R	855	100	1	MR25	5322 116 54469
R	856	750	1	MR25	4822 116 51234
R	857	95,3	1	MR25	5322 116 50569
R	858	33,2	1	MR25	5322 116 50527
R	859	825	1	MR25	5322 116 54541
R	861	33,2	1	MR25	5322 116 50527
R	862	78,7	1	MR25	5322 116 50578
R	863	261	1	MR25	5322 116 54502
R	864	121	1	MR25	5322 116 54426
R	865	5,11	1	MR25	5322 116 54192
R	866	121	1	MR25	5322 116 54426
R	867	33,2	1	MR25	5322 116 50527

POSNR	DESCRIPTION			ORDERING CODE
R 868	316	1	MR25	5322 116 54511
R 869	332	1	MR25	4822 116 51226
R 870	100	1	MR25	5322 116 54469
R 871	90,9	1	MR25	5322 116 54466
R 872	22,6	1	MR25	5322 116 50491
R 873	16,2K	1	MR25	5322 116 55361
R 874	100	1	MR25	5322 116 54469
R 875	22,6	1	MR25	5322 116 50491
R 876	22,6	1	MR25	5322 116 50491
R 877	909	1	MR25	5322 116 55278
R 878	681	1	MR25	4822 116 51233
R 879	1,87K	1	MR25	5322 116 50728
R 881	10K	20	0.75W	5322 100 10141
R 882	150	1	MR25	5322 116 54486
R 883	316	1	MR25	5322 116 54511
R 884	332	1	MR25	4822 116 51226
R 885	51,1	1	MR25	5322 116 54442
R 886	90,9	1	MR25	5322 116 54466
R 887	22,6	1	MR25	5322 116 50491
R 888	16,2K	1	MR25	5322 116 55361
R 889	100	1	MR25	5322 116 54469
R 890	5,11	1	MR25	5322 116 54192
R 891	22,6	1	MR25	5322 116 50491
R 892	22,6	1	MR25	5322 116 50491
R 893	316	1	MR25	5322 116 54511
R 894	51,1	1	MR25	5322 116 54442
R 896	274	1	MR25	5322 116 54504
R 897	316	1	MR25	5322 116 54511
R 898	1K	1	MR25	5322 116 54549
R 899	10K	1	MR25	4822 116 51253
R 900	1,69K	1	MR25	5322 116 54567
R 901	2,05K	1	MR25	5322 116 50664
R 902	1K	1	MR25	5322 116 54549
R 903	825	1	MR25	5322 116 54541
R 904	33,2	1	MR25	5322 116 50527
R 905	301	1	MR25	5322 116 54508
R 906	464	1	MR25	5322 116 50536
R 907	464	1	MR25	5322 116 50536
R 908	2,26K	1	MR25	5322 116 50675
R 909	2,26K	1	MR25	5322 116 50675
R 910	7,15K	1	MR25	5322 116 54606
R 911	10K	20	0.75W	5322 100 10141
R 912	5,11K	1	MR25	5322 116 54595
R 913	10K	20	0.75W	5322 100 10141
R 914	750	1	MR25	4822 116 51234
R 916	2,49K	1	MR25	5322 116 50581
R 917	10K	1	MR25	4822 116 51253
R 918	3,83K	1	MR25	5322 116 54589
R 919	33E2	1	MR25	5322 116 50527
R 920	301	1	MR25	5322 116 54508
R 921	12,1K	1	MR25	5322 116 50572
R 922	5,9K	1	MR25	5322 116 50583
R 923	33,2	1	MR25	5322 116 50527
R 924	33,2	1	MR25	5322 116 50527
R 926	487	0,25	MR24C	5322 116 54249
R 927	22,6K	1	MR25	5322 116 50481
R 928	1K	1	MR25	5322 116 54549
R 929	22,6K	1	MR25	5322 116 50481
R 931	464	1	MR25	5322 116 50536
R 932	22,6K	1	MR25	5322 116 50481
R 933	1K	1	MR25	5322 116 54549
R 934	38,3	1	MR25	5322 116 50954
R 936	10K	1	MR25	4822 116 51253
R 937	10K	1	MR25	4822 116 51253
R 938	5,6M	10	CR25	4822 110 72207
R 939	10K	1	MR25	4822 116 51253

POSNR		DESCRIPTION			ORDERING CODE
R	940	332	1	MR25	4822 116 51226
R	941	5,11	1	MR25	5322 116 54192
R	942	2,05K	1	MR25	5322 116 50664
R	943	68,1	1	MR25	5322 116 54455
R	944	33,2K	1	MR25	4822 116 51259
R	945	33,2	1	MR25	5322 116 50527
R	946	2,49K	1	MR25	5322 116 50581
R	947	2,05K	1	MR25	5322 116 50664
R	948	2,26K	1	MR25	5322 116 50675
R	949	90,9	1	MR25	5322 116 54466
R	950	511	1	MR25	4822 116 51282
R	951	332	1	MR25	4822 116 51226
R	952	274	1	MR25	5322 116 54504
R	953	100	1	MR25	5322 116 54469
R	954	274	1	MR25	5322 116 54504
R	955	5,11K	1	MR25	5322 116 54595
R	956	750	1	MR25	4822 116 51234
R	957	22,6	1	MR25	5322 116 50491
R	958	750	1	MR25	4822 116 51234
R	959	3,32K	1	MR25	5322 116 54005
R	960	6,81K	1	MR25	5322 116 54012
R	961	1K	1	MR25	5322 116 54549
R	962	1K	1	MR25	5322 116 54549
R	963	205	1	MR25	5322 116 50669
R	964	22,6K	1	MR25	5322 116 50481
R	965	33,2K	1	MR25	4822 116 51259
R	966	562	1	MR25	5322 116 54009
R	967	274	1	MR25	5322 116 54504
R	968	274	1	MR25	5322 116 54504
R	969	100	1	MR25	5322 116 54469
R	970	10K	1	MR25	4822 116 51253
R	971	1,47K	1	MR25	5322 116 50635
R	972	10K	1	MR25	4822 116 51253
R	973	464	1	MR25	5322 116 50536
R	974	16,2K	1	MR25	5322 116 55361
R	975	100	1	MR25	5322 116 54469
R	976	33,2K	1	MR25	4822 116 51259
R	977	15,4K	1	MR25	5322 116 50479
R	978	1,47K	1	MR25	5322 116 50635
R	980	10K	1	MR25	4822 116 51253
R	981	1K	1	MR25	5322 116 54549
R	982	1K	1	MR25	5322 116 54549
R	983	22,6K	1	MR25	5322 116 50481
R	984	402	1	MR25	5322 116 54519
R	985	619K	1	MR25	5322 116 55315
R	986	33,2	1	MR25	5322 116 50527
R	987	33,2K	1	MR25	4822 116 51259
R	988	4,64K	1	MR25	5322 116 50484
R	989	4,64K	1	MR25	5322 116 50484
R	990	21,5K	1	MR25	5322 116 50451
R	991	10K	1	MR25	4822 116 51253
R	992	1,87K	1	MR25	5322 116 50728
R	993	1K	1	MR25	5322 116 54549
R	994	2,15K	1	MR25	5322 116 50767
R	995	301	1	MR25	5322 116 54508
R	996	301	1	MR25	5322 116 54508

POSNR	DESCRIPTION			ORDERING CODE
R 997	51,1	1	MR25	5322 116 54442
R 998	10K	1	MR25	4822 116 51253
R 1001	402	0,25	MR24C	5322 116 54877
R 1002	876K	0,25	MR54C	5322 116 54902
R 1003	887K	0,25	MR54C	5322 116 54901
R 1004	354K	0,25	MR34C	5322 116 54896
R 1006	176K	0,25	MR34C	5322 116 54899
R 1007	87,6K	0,25	MR24C	5322 116 54897
R 1008	34,6K	0,25	MR24C	5322 116 54895
R 1009	16,8K	0,25	MR24C	5322 116 54894
R 1011	7,96K	0,25	MR24C	5322 116 55161
R 1012	2,67K	0,25	MR24C	5322 116 50784
R 1013	887	0,25	MR24C	5322 116 54898
R 1014	274	1	MR25	5322 116 54504
R 1101	33,2	1	MR25	5322 116 50527
R 1102	750K	1	MR30	5322 116 54335
R 1103	1K	1	MR25	5322 116 54549
R 1104	1K	1	MR25	5322 116 54549
R 1106	249K	1	MR25	5322 116 54386
R 1107	10M	10	CR25	4822 110 72214
R 1108	1,78K	1	MR25	5322 116 50515
R 1109	33,2	1	MR25	5322 116 50527
R 1111	6,81K	1	MR25	5322 116 54012
R 1112	24,9K	1	MR25	5322 116 54648
R 1113	1,05K	1	MR25	5322 116 54552
R 1114	187K	1	MR25	5322 116 54723
R 1116	8,25K	1	MR25	5322 116 54558
R 1117	71,5K	1	MR25	5322 116 54685
R 1118	10K	20	0,5W	5322 100 10113
R 1201	3,48K	1	MR25	5322 116 54585
R 1202	8,25K	1	MR25	5322 116 54558
R 1203	332	1	MR25	4822 116 51226
R 1204	33,2	1	MR25	5322 116 50527
R 1205	4,99	1	MR25	5322 116 50568
R 1206	33,2	1	MR25	5322 116 50527
R 1207	46,4	1	MR25	5322 116 50492
R 1208	51,1	1	MR25	5322 116 54442
R 1211	100	1	MR25	5322 116 54469
R 1212	511	1	MR25	4822 116 51282
R 1213	750	1	MR25	4822 116 51234
R 1214	750	1	MR25	4822 116 51234
R 1216	511	1	MR25	4822 116 51282
R 1217	100	1	MR25	5322 116 54469
R 1218	51,1	1	MR25	5322 116 54442
R 1219	51,1	1	MR25	5322 116 54442
R 1221	1,47K	1	MR25	5322 116 50635
R 1222	1,47K	1	MR25	5322 116 50635
R 1223	18,7K	1	MR25	5322 116 50558
R 1224	18,7K	1	MR25	5322 116 50558
R 1226	100	1	MR25	5322 116 54469
R 1227	1,47K	1	MR25	5322 116 50635
R 1228	1,47K	1	MR25	5322 116 50635
R 1229	18,7K	1	MR25	5322 116 50558
R 1231	18,7K	1	MR25	5322 116 50558
R 1232	100	1	MR25	5322 116 54469
R 1233	1,47K	1	MR25	5322 116 50635
R 1234	1,47K	1	MR25	5322 116 50635
R 1236	18,7K	1	MR25	5322 116 50558
R 1237	18,7K	1	MR25	5322 116 50558
R 1238	1K	20	0.75W	5322 100 10143
R 1239	100	1	MR25	5322 116 54469
R 1241	22,6	1	MR25	5322 116 50491
R 1242	100	1	MR25	5322 116 54469
R 1243	750	1	MR25	4822 116 51234
R 1244	59	1	MR25	5322 116 54448

POSNR	DESCRIPTION			ORDERING CODE
R 1246	33,2	1	MR25	5322 116 50527
R 1247	78,7	1	MR25	5322 116 50578
R 1248	825	1	MR25	5322 116 54541
R 1249	33,2	1	MR25	5322 116 50527
R 1251	261	1	MR25	5322 116 54502
R 1252	121	1	MR25	5322 116 54426
R 1253	121	1	MR25	5322 116 54426
R 1254	33,2	1	MR25	5322 116 50527
R 1256	316	1	MR25	5322 116 54511
R 1257	332	1	MR25	4822 116 51226
R 1258	90,9	1	MR25	5322 116 54466
R 1259	22,6	1	MR25	5322 116 50491
R 1261	100	1	MR25	5322 116 54469
R 1262	649	1	MR25	5322 116 54532
R 1263	649	1	MR25	5322 116 54532
R 1264	316	1	MR25	5322 116 54511
R 1266	332	1	MR25	4822 116 51226
R 1267	90,9	1	MR25	5322 116 54466
R 1268	22,6	1	MR25	5322 116 50491
R 1271	16,2K	1	MR25	5322 116 55361
R 1272	316	1	MR25	5322 116 54511
R 1273	100	1	MR25	5322 116 54469
R 1274	22,6	1	MR25	5322 116 50491
R 1276	22,6	1	MR25	5322 116 50491
R 1277	150	1	MR25	5322 116 54486
R 1278	51,1	1	MR25	5322 116 54442
R 1281	274	1	MR25	5322 116 54504
R 1282	22,6	1	MR25	5322 116 50491
R 1283	100	1	MR25	5322 116 54469
R 1284	22,6	1	MR25	5322 116 50491
R 1286	100	1	MR25	5322 116 54469
R 1287	16,2K	1	MR25	5322 116 55361
R 1288	316	1	MR25	5322 116 54511
R 1289	1K	1	MR25	5322 116 54549
R 1291	10K	1	MR25	4822 116 51253
R 1292	5,11	1	MR25	5322 116 54192
R 1293	51,1	1	MR25	5322 116 54442
R 1300	1,4K	1	MR25	5322 116 54562
R 1301	2,26K	1	MR25	5322 116 50675
R 1303	750	1	MR25	4822 116 51234
R 1304	4,87K	1	MR25	5322 116 50509
R 1305	3,01K	1	MR25	4822 116 51246
R 1306	274	1	MR25	5322 116 54504
R 1307	274	1	MR25	5322 116 54504
R 1308	2,05K	1	MR25	5322 116 50664
R 1309	464	1	MR25	5322 116 50536
R 1310	10K	1	MR25	4822 116 51253
R 1311	100	1	MR25	5322 116 54469
R 1312	464	1	MR25	5322 116 50536
R 1313	1K	1	MR25	5322 116 54549
R 1314	33,2	1	MR25	5322 116 50527
R 1315	10K	1	MR25	4822 116 51253
R 1316	4,42K	1	MR25	5322 116 50556
R 1317	2,26K	1	MR25	5322 116 50675
R 1318	10K	20	0.75W	5322 100 10141

POSNR	DESCRIPTION			ORDERING CODE
R 1319	2,26K	1	MR25	5322 116 50675
R 1320	10K	1	MR25	4822 116 51253
R 1321	10K	20	0.75W	5322 100 10141
R 1322	5,11K	1	MR25	5322 116 54595
R 1323	750	1	MR25	4822 116 51234
R 1324	5,11K	1	MR25	5322 116 54595
R 1326	10K	20	0.75W	5322 100 10141
R 1327	3,83K	1	MR25	5322 116 54589
R 1328	10K	1	MR25	4822 116 51253
R 1329	33,2	1	MR25	5322 116 50527
R 1331	12,1K	1	MR25	5322 116 50572
R 1332	5,9K	1	MR25	5322 116 50583
R 1333	33,2	1	MR25	5322 116 50527
R 1334	33,2	1	MR25	5322 116 50527
R 1335	4,64K	1	MR25	5322 116 50484
R 1336	887	0,25	MR24C	5322 116 54898
R 1337	22,6K	1	MR25	5322 116 50481
R 1338	1K	1	MR25	5322 116 54549
R 1339	22,6K	1	MR25	5322 116 50481
R 1341	464	1	MR25	5322 116 50536
R 1342	22,6K	1	MR25	5322 116 50481
R 1343	1K	1	MR25	5322 116 54549
R 1344	38,3	1	MR25	5322 116 50954
R 1346	10K	1	MR25	4822 116 51253
R 1347	68,1	1	MR25	5322 116 54455
R 1348	33,2K	1	MR25	4822 116 51259
R 1349	2,49K	1	MR25	5322 116 50581
R 1350	332	1	MR25	4822 116 51226
R 1351	5,6M	10	CR25	4822 110 72207
R 1352	5,11	1	MR25	5322 116 54192
R 1353	2,05K	1	MR25	5322 116 50664
R 1354	10K	1	MR25	4822 116 51253
R 1355	33,2	1	MR25	5322 116 50527
R 1356	10K	1	MR25	4822 116 51253
R 1357	15,4K	1	MR25	5322 116 50479
R 1358	1,47K	1	MR25	5322 116 50635
R 1359	274	1	MR25	5322 116 54504
R 1360	953	1	MR25	5322 116 54547
R 1361	274	1	MR25	5322 116 54504
R 1362	953	1	MR25	5322 116 54547
R 1363	4,64K	1	MR25	5322 116 50484
R 1364	100	1	MR25	5322 116 54469
R 1365	787	1	MR25	5322 116 54538
R 1366	1,33K	1	MR25	5322 116 54561
R 1367	3,32K	1	MR25	5322 116 54005
R 1368	3,32K	1	MR25	5322 116 54005
R 1369	2,61K	1	MR25	5322 116 50671
R 1370	1K	1	MR25	5322 116 54549
R 1371	100	1	MR25	5322 116 54469
R 1372	100	1	MR25	5322 116 54469
R 1373	33,2	1	MR25	5322 116 50527
R 1374	33,2	1	MR25	5322 116 50527
R 1376	5,11K	1	MR25	5322 116 54595
R 1377	3,32K	1	MR25	5322 116 54005
R 1378	15,4K	1	MR25	5322 116 50479
R 1379	10K	20	0.75W	5322 100 10141
R 1381	33,2	1	MR25	5322 116 50527
R 1382	5,62K	1	MR25	4822 116 51281
R 1383	2,26K	1	MR25	5322 116 50675
R 1384	10K	20	0.75W	5322 100 10141
R 1386	301	1	MR25	5322 116 54508
R 1387	590	1	MR25	5322 116 50561
R 1388	301	1	MR25	5322 116 54508
R 1389	909	1	MR25	5322 116 55278
R 1391	909	1	MR25	5322 116 55278

POSNR	DESCRIPTION			ORDERING CODE
R 1392	1,47K	1	MR25	5322 116 50635
R 1393	750	1	MR25	4822 116 51234
R 1394	1K	1	MR25	5322 116 54549
R 1396	301	1	MR25	5322 116 54508
R 1397	301	1	MR25	5322 116 54508
R 1398	2,15K	1	MR25	5322 116 50767
R 1401	887K	0,25	MR54C	5322 116 54901
R 1402	354K	0,25	MR34C	5322 116 54896
R 1403	176K	0,25	MR34C	5322 116 54899
R 1404	87,6K	0,25	MR24C	5322 116 54897
R 1406	34,6K	0,25	MR24C	5322 116 54895
R 1407	16,8K	0,25	MR24C	5322 116 54894
R 1408	7,96K	0,25	MR24C	5322 116 55161
R 1409	2,67K	0,25	MR24C	5322 116 50784
R 1411	887	0,25	MR24C	5322 116 54898
R 1501	1K	1	MR25	5322 116 54549
R 1502	10K	1	MR25	4822 116 51253
R 1503	33,2	1	MR25	5322 116 50527
R 1504	33,2K	1	MR25	4822 116 51259
R 1506	10K	1	MR25	4822 116 51253
R 1507	3,32K	1	MR25	5322 116 54005
R 1508	402	1	MR25	5322 116 54519
R 1509	3,32K	1	MR25	5322 116 54005
R 1511	402	1	MR25	5322 116 54519
R 1512	1K	1	MR25	5322 116 54549
R 1513	1K	1	MR25	5322 116 54549
R 1514	10K	1	MR25	4822 116 51253
R 1515	464	1	MR25	5322 116 50536
R 1516	10K	1	MR25	4822 116 51253
R 1517	33,2	1	MR25	5322 116 50527
R 1518	33,2K	1	MR25	4822 116 51259
R 1519	12,1K	1	MR25	5322 116 50572
R 1520	6,81K	1	MR25	5322 116 54012
R 1521	4,02K	1	MR25	5322 116 55448
R 1522	33,2K	1	MR25	4822 116 51259
R 1523	5,11K	1	MR25	5322 116 54595
R 1524	7,87K	1	MR25	5322 116 50458
R 1525	46,4	1	MR25	5322 116 50492
R 1526	1,87K	1	MR25	5322 116 50728
R 1527	33,2	1	MR25	5322 116 50527
R 1528	15,4K	1	MR25	5322 116 50479
R 1529	2,26K	1	MR25	5322 116 50675
R 1531	1,4K	1	MR25	5322 116 54562
R 1532	33,2K	1	MR25	4822 116 51259
R 1533	10K	1	MR25	4822 116 51253
R 1534	22,6K	1	MR25	5322 116 50481
R 1535	24,9K	1	MR25	5322 116 54648
R 1536	15,4K	1	MR25	5322 116 50479
R 1537	10K	20	0.75W	5322 100 10141
R 1538	15,4K	1	MR25	5322 116 50479
R 1539	1,21K	1	MR25	5322 116 54557
R 1541	100	1	MR25	5322 116 54469
R 1542	1,21K	1	MR25	5322 116 54557
R 1543	24,9K	1	MR25	5322 116 54648
R 1549	470	20	0.75W	5322 100 10135

POSNR	DESCRIPTION			ORDERING CODE
R 1550	215	1	MR25	5322 116 55274
R 1551	787	1	MR25	5322 116 54538
R 1552	1,78K	1	MR25	5322 116 50515
R 1553	1,62K	1	MR25	5322 116 55359
R 1554	332	1	MR25	4822 116 51226
R 1555	3,01K	1	MR25	4822 116 51246
R 1556	68,1K	1	MR25	5322 116 54683
R 1557	226	1	MR25	5322 116 54497
R 1558	1K	1	MR25	5322 116 54549
R 1559	13,7K	1	MR25	5322 116 54628
R 1561	11,5K	1	MR25	5322 116 55358
R 1562	332	1	MR25	4822 116 51226
R 1563	5,11K	1	MR25	5322 116 54595
R 1564	42,2	1	MR25	5322 116 51052
R 1566	332	1	MR25	4822 116 51226
R 1567	2,05K	1	MR25	5322 116 50664
R 1568	2,26K	1	MR25	5322 116 50675
R 1569	3,32K	1	MR25	5322 116 54005
R 1570	100	1	MR25	5322 116 54469
R 1571	332	1	MR25	4822 116 51226
R 1572	68,1K	1	MR25	5322 116 54683
R 1573	140	1	MR25	5322 116 54484
R 1574	6,19K	1	MR25	5322 116 50608
R 1576	5,11K	1	MR25	5322 116 54595
R 1577	332	1	MR25	4822 116 51226
R 1578	42,2	1	MR25	5322 116 51052
R 1579	1,4K	1	MR25	5322 116 54562
R 1581	332	1	MR25	4822 116 51226
R 1601	681	1	MR25	4822 116 51233
R 1602	4,02K	1	MR25	5322 116 55448
R 1603	6,19K	1	MR25	5322 116 50608
R 1604	4,64K	1	MR25	5322 116 50484
R 1606	4,02K	1	MR25	5322 116 55448
R 1607	1K	1	MR25	5322 116 54549
R 1608	17,8K	1	MR25	5322 116 54637
R 1609	1,54K	1	MR25	5322 116 50586
R 1611	1,54K	1	MR25	5322 116 50586
R 1612	1K	1	MR25	5322 116 54549
R 1613	2,05K	1	MR25	5322 116 50664
R 1614	2,05K	1	MR25	5322 116 50664
R 1615	1K	1	MR25	5322 116 54549
R 1616	332	1	MR25	4822 116 51226
R 1617	2,05K	1	MR25	5322 116 50664
R 1618	2,05K	1	MR25	5322 116 50664
R 1619	1K	1	MR25	5322 116 54549
R 1621	1K	1	MR25	5322 116 54549
R 1622	100	1	MR25	5322 116 54469
R 1627	5,23K	1	MR25	5322 116 54596
R 1628	5,23K	1	MR25	5322 116 54596
R 1629	5,23K	1	MR25	5322 116 54596
R 1630	10	1	MR25	5322 116 50452
R 1651	787	1	MR25	5322 116 54538
R 1652	1,78K	1	MR25	5322 116 50515
R 1653	14,7K	1	MR25	5322 116 54632
R 1654	4,7K	20	0.75W	5322 100 10139
R 1659	3,16K	1	MR25	5322 116 50579
R 1661	2,61K	1	MR25	5322 116 50671
R 1664	3,16K	1	MR25	5322 116 50579
R 1667	33,2	1	MR25	5322 116 50527
R 1668	33,2	1	MR25	5322 116 50527
R 1669	787	1	MR25	5322 116 54538
R 1671	1,78K	1	MR25	5322 116 50515
R 1672	14,7K	1	MR25	5322 116 54632
R 1673	4,7K	20	0.75W	5322 100 10139
R 1678	3,16K	1	MR25	5322 116 50579

POSNR	DESCRIPTION			ORDERING CODE
R 1679	33,2	1	MR25	5322 116 50527
R 1681	33,2	1	MR25	5322 116 50527
R 1682	2,61K	1	MR25	5322 116 50671
R 1686	3,16K	1	MR25	5322 116 50579
R 1701	487	1	MR25	5322 116 55451
R 1702	649	1	MR25	5322 116 54532
R 1703	33,2	1	MR25	5322 116 50527
R 1704	162	1	MR25	5322 116 50417
R 1706	1K	20	0,5W	5322 100 10112
R 1707	110	1	MR25	5322 116 54474
R 1708	2,49K	1	MR25	5322 116 50581
R 1709	10K	20	0,5W	5322 100 10113
R 1710	9,53K	1	MR25	5322 116 54617
R 1711	549	1	MR25	5322 116 50732
R 1712	549	1	MR25	5322 116 50732
R 1713	12,1K	1	MR25	5322 116 50572
R 1714	10K	1	MR25	4822 116 51253
R 1715	9,53K	1	MR25	5322 116 54617
R 1716	402	1	MR25	5322 116 54519
R 1718	12,1K	1	MR25	5322 116 50572
R 1719	22,6	1	MR25	5322 116 50491
R 1721	33,2	1	MR25	5322 116 50527
R 1722	82,5K	1	MR25	5322 116 54689
R 1723	15,4K	1	MR25	5322 116 50479
R 1724	100K	1	MR25	4822 116 51268
R 1726	19,6K	1	MR25	5322 116 54641
R 1727	2,61K	1	MR25	5322 116 50671
R 1728	649	1	MR25	5322 116 54532
R 1729	100	1	MR25	5322 116 54469
R 1731	22,6K	1	MR25	5322 116 50481
R 1732	511	1	MR25	4822 116 51282
R 1733	1K	1	MR25	5322 116 54549
R 1734	402	1	MR25	5322 116 54519
R 1736	301K	1	MR25	5322 116 54743
R 1737	1M	20	0,5W	5322 101 14094
R 1738	1K	1	MR25	5322 116 54549
R 1739	402	1	MR25	5322 116 54519
R 1741	301K	1	MR25	5322 116 54743
R 1742	511	1	MR25	4822 116 51282
R 1743	82,5	1	MR25	5322 116 54462
R 1744	22,6K	1	MR25	5322 116 50481
R 1746	7,15K	1	MR25	5322 116 54606
R 1747	649	1	MR25	5322 116 54532
R 1748	10K	1	MR25	4822 116 51253
R 1749	10K	20	0,5W	5322 100 10113
R 1751	100K	1	MR25	4822 116 51268
R 1752	100K	1	MR25	4822 116 51268
R 1801	301K	1	MR25	5322 116 54743
R 1802	301K	1	MR25	5322 116 54743
R 1803	1M	5	VR37	4822 110 42187
R 1804	3,3K	5	4W	4822 112 21121
R 1805	1M	5	VR37	4822 110 42187
R 1806	1K5	25%		5322 116 34051
R 1807	82,5K	0,5	MR30	5322 116 54935
R 1808	82,5K	0,5	MR30	5322 116 54935

POSNR	DESCRIPTION			ORDERING CODE
R 1809	82,5K	0,5	MR30	5322 116 54935
R 1810	4,42K	1	MR25	5322 116 50556
R 1811	1,62	1	MR25	5322 116 55337
R 1812	100	1	MR25	5322 116 54469
R 1813	22,6	1	MR25	5322 116 50491
R 1814	20	5	PR52	5322 116 54351
R 1816	2K	5	PR52	5322 116 55205
R 1817	10M	10	CR25	4822 110 72214
R 1818	10M	10	CR25	4822 110 72214
R 1819	24,9K	1	MR25	5322 116 54648
R 1822	1,74K	1	MR25	5322 116 50629
R 1823	100K	1	MR25	4822 116 51268
R 1824	22,6K	1	MR25	5322 116 50481
R 1826	1K	20	0.75W	5322 100 10143
R 1827	10K	20	0,5W	5322 100 10113
R 1828	11K	1	MR25	5322 116 54623
R 1829	4,64K	1	MR25	5322 116 50484
R 1830	33,2K	1	MR25	4822 116 51259
R 1831	5,9K	1	MR25	5322 116 50583
R 1832	3,32K	1	MR25	5322 116 54005
R 1833	6,81K	1	MR25	5322 116 54012
R 1834	249	1	MR25	5322 116 54499
R 1836	12,1K	1	MR25	5322 116 50572
R 1837	249	1	MR25	5322 116 54499
R 1838	140	1	MR25	5322 116 54484
R 1839	1	5	CR25	4822 110 73027
R 1846	121K	1	MR25	5322 116 54704
R 1847	121K	1	MR25	5322 116 54704
R 1848	3,9M	5	VR25	4822 110 72203
R 1849	10K	1	MR25	4822 116 51253
R 1851	68,1K	1	MR25	5322 116 54683
R 1852	249K	1	MR25	5322 116 54386
R 1853	511K	1	MR25	5322 116 55258
R 1854	1M	5	CR25	4822 110 73187
R 1856	1,33K	1	MR25	5322 116 54561
R 1857	1,33K	1	MR25	5322 116 54561
R 1858	1K	1	MR25	5322 116 54549
R 1861	20M	5	VR68	5322 116 64078
R 1862	1M	5	VR37	4822 110 42187
R 1901	82,5	1	MR25	5322 116 54462
R 1902	19,6K	1	MR25	5322 116 54641
R 1903	6,19K	1	MR25	5322 116 50608
R 1904	316	1	MR25	5322 116 54511
R 1906	10K	20	0.75W	5322 100 10141
R 1907	750	1	MR25	4822 116 51234
R 1908	1,33K	1	MR25	5322 116 54561
R 1909	6,19K	1	MR25	5322 116 50608
R 1911	499	1	MR25	5322 116 54524
R 1912	100	1	MR25	5322 116 54469
R 1914	274	1	MR25	5322 116 54504
R 2000	42,2	1	MR25	5322 116 51052
R 2001	42,2	1	MR25	5322 116 51052
R 2002	42,2	1	MR25	5322 116 51052
R 2003	1,62K	1	MR25	5322 116 55359
R 2006	22,6	1	MR25	5322 116 50491
R 2007	2,87K	1	MR25	5322 116 50414
R 2008	4,02K	1	MR25	5322 116 55448
R 2009	12,7K	1	MR25	5322 116 50443
R 2011	464	1	MR25	5322 116 50536
R 2012	7,15K	1	MR25	5322 116 54606
R 2013	511	1	MR25	4822 116 51282
R 2014	1,69K	1	MR25	5322 116 54567
R 2015	7,15K	1	MR25	5322 116 54606
R 2016	2,74K	1	MR25	5322 116 50636
R 2017	22,6K	1	MR25	5322 116 50481

POSNR	DESCRIPTION			ORDERING CODE
R 2018	10K	1	MR25	4822 116 51253
R 2019	100	1	MR25	5322 116 54469
R 2020	10K	1	MR25	4822 116 51253
R 2021	2,26K	1	MR25	5322 116 50675
R 2022	205	1	MR25	5322 116 50669
R 2023	1,1K	1	MR25	4822 116 51236
R 2024	10K	20	0,5W	5322 100 10113
R 2025	100	1	MR25	5322 116 54469
R 2026	1,1K	1	MR25	4822 116 51236
R 2027	5,36K	1	MR25	5322 116 54597
R 2028	205K	1	MR25	5322 116 54727
R 2029	8,25K	1	MR25	5322 116 54558
R 2030	61,9K	1	MR25	5322 116 50872
R 2033	2,49K	1	MR25	5322 116 50581
R 2034	2,49K	1	MR25	5322 116 50581
R 2035	100	1	MR25	5322 116 54469
R 2036	19,6K	1	MR25	5322 116 54641
R 2037	332	1	MR25	4822 116 51226
R 2041	5,36K	1	MR25	5322 116 54597
R 2042	205K	1	MR25	5322 116 54727
R 2043	8,25K	1	MR25	5322 116 54558
R 2047	2,49K	1	MR25	5322 116 50581
R 2048	10K	1	MR25	4822 116 51253
R 2049	2,49K	1	MR25	5322 116 50581
R 2050	100	1	MR25	5322 116 54469
R 2051	332	1	MR25	4822 116 51226
R 2053	147K	1	MR25	5322 116 54712
R 2054	5,11K	1	MR25	5322 116 54595
R 2055	22,6	1	MR25	5322 116 50491
R 2056	22,6	1	MR25	5322 116 50491
R 2057	215	1	MR25	5322 116 55274
R 2058	22NF	80%	63V	4822 122 30103
R 2059	95,3K	1	MR25	5322 116 50567
R 2061	64,9K	1	MR25	5322 116 50514
R 2062	12,1K	1	MR25	5322 116 50572
R 2063	2,74K	1	MR25	5322 116 50636
R 2064	10K	20	0,5W	5322 100 10113
R 2070	2,7M	5	VR25	4822 110 72198
R 2071	2,7M	5	VR25	4822 110 72198
R 2072	2,7M	5	VR25	4822 110 72198
R 2073	1,2M	5	CR25	4822 110 72189
R 2074	348K	1	MR25	5322 116 55499
R 2076	15M	5	VR37	4822 110 42218
R 2077	15M	5	VR37	4822 110 42218
R 2078	13M	5	VR37	5322 116 64018
R 2079	8,2M	5	VR37	4822 110 42212
R 2081	1K	1	MR25	5322 116 54549
R 2082	1M	5	CR25	4822 110 73187
R 2083	1M	5	CR25	4822 110 73187
R 2084	100K	1	MR25	4822 116 51268
R 2086	33M	5	VR37	4822 110 42227
R 2087	8,2M	5	VR37	4822 110 42212
R 2088	21,5K	1	MR25	5322 116 50451
R 2089	953K	1	MR25	5322 116 51368
R 2090	59K	1	MR25	5322 116 54678

POSNR	DESCRIPTION			ORDERING CODE
R 2091	100	1	MR25	5322 116 54469
R 2092	100	1	MR25	5322 116 54469
R 2094	33M	5	VR37	4822 110 42227
R 2101	1,8M	10	CR25	4822 110 72194
R 2102	100K	20	0.5W	5322 101 14071
R 2103	100K	20	0.5W	5322 101 14071
R 2106	301K	1	MR25	5322 116 54743
R 2107	100	1	MR25	5322 116 54469
R 211	10K	20	0.75W	5322 100 10141
R 2113	1K	1	MR25	5322 116 54549
R 2116	1K	1	MR25	5322 116 54549
R 2117	33,2K	1	MR25	4822 116 51259
R 2118	22,6	1	MR25	5322 116 50491
R 2121	169K	1	MR25	5322 116 54718
R 2122	681K	1	MR25	5322 116 55284
R 2123	10K	20	0,5W	5322 100 10113
R 2124	100	1	MR25	5322 116 54469
R 2127	22,6	1	MR25	5322 116 50491
R 2128	22,6	1	MR25	5322 116 50491
R 2129	22,6	1	MR25	5322 116 50491
R 2131	22,6	1	MR25	5322 116 50491
R 2133	38,3K	1	MR25	5322 116 55369
R 2134	590K	1	MR25	5322 116 55567
R 2136	2,7M	5	VR25	4822 110 72198
R 2137	2,7M	5	VR25	4822 110 72198
R 2141	20,5K	1	MR25	5322 116 54643
R 2142	4,64K	1	MR25	5322 116 50484
R 2143	464K	1	MR25	5322 116 55207
R 2144	316K	1	MR25	5322 116 55268
R 2201	10K	1	MR25	4822 116 51253
R 2202	100K	2	5X0.2W	5322 111 94163
R 2203	100K	1	MR25	4822 116 51268
R 2204	301K	1	MR25	5322 116 54743
R 2207	1M	5	CR25	4822 110 73187
R 2211	1,5M	10	CR25	4822 110 72192
R 2213	10	1	MR25	5322 116 50452
R 2216	100K	1	MR25	4822 116 51268
R 2222	8,2M	10	CR25	4822 110 72212
R 2223	4,7M	10	CR25	4822 110 72203
R 2224	4,7M	10	CR25	4822 110 72203
R 2226	100K	1	MR25	4822 116 51268
R 2227	4,7M	10	CR25	4822 110 72203
R 2228	22,6K	1	MR25	5322 116 50481
R 2229	4,64K	1	MR25	5322 116 50484
R 2232	10	1	MR25	5322 116 50452
R 2233	22,6K	1	MR25	5322 116 50481
R 2237	4,64K	1	MR25	5322 116 50484
R 2238	22,6K	1	MR25	5322 116 50481
R 2239	22,6K	1	MR25	5322 116 50481
R 2241	100K	2	5X0.2W	5322 111 94163
R 2242	100K	2	5X0.2W	5322 111 94163
R 2243	100K	1	MR25	4822 116 51268
R 2246	680K	5	CR25	4822 110 73183
R 2247	100	1	MR25	5322 116 54469
R 2248	4,87K	1	MR25	5322 116 50509
R 2249	12,7K	1	MR25	5322 116 50443
R 2251	46,4	1	MR25	5322 116 50492
R 2252	51,1K	1	MR25	5322 116 50672
R 2253	6,19K	1	MR25	5322 116 50608
R 2254	100K	1	MR25	4822 116 51268
R 2256	681K	1	MR25	5322 116 55284
R 2257	10K	1	MR25	4822 116 51253
R 2258	46,4K	1	MR25	5322 116 50557
R 2259	20,5K	1	MR25	5322 116 54643
R 2261	681K	1	MR25	5322 116 55284

POSNR	DESCRIPTION			ORDERING CODE
R 2262	13,3K	1	MR25	5322 116 55276
R 2263	14,7K	1	MR25	5322 116 54632
R 2264	100K	1	MR25	4822 116 51268
R 2266	100K	1	MR25	4822 116 51268
R 2267	100K	1	MR25	4822 116 51268
R 2272	100K	1	MR25	4822 116 51268
R 2274	100K	1	MR25	4822 116 51268
R 2276	1,5M	10	CR25	4822 110 72192
R 2277	100K	1	MR25	4822 116 51268
R 2278	1,78K	1	MR25	5322 116 50515
R 2284	100	1	MR25	5322 116 54469
R 2287	383	1	MR25	5322 116 54518
R 2288	866K	1	MR25	5322 116 51395
R 2293	1M	5	CR25	4822 110 73187
R 2294	10,5K	1	MR25	5322 116 50731
R 2297	46,4K	1	MR25	5322 116 50557
R 2298	10,5K	1	MR25	5322 116 50731
R 2299	16,9K	1	MR25	5322 116 54635
R 2302	1,5M	10	CR25	4822 110 72192
R 2303	100K	1	MR25	4822 116 51268
R 2304	100K	1	MR25	4822 116 51268
R 2306	100K	2	5X0.2W	5322 111 94163
R 2309	100K	2	5X0.2W	5322 111 94163
R 2311	4,64K	1	MR25	5322 116 50484
R 2312	22,6K	1	MR25	5322 116 50481
R 2314	3,3M	10	CR25	4822 110 72201
R 2401	7,15K	1	MR25	5322 116 54606
R 2402	4,87K	1	MR25	5322 116 50509
R 2403	4,64K	1	MR25	5322 116 50484
R 2404	10K	20	0.75W	5322 100 10141
R 2406	5,62K	1	MR25	4822 116 51281
R 2407	28,7K	1	MR25	5322 116 54653
R 2408	10K	20	0.75W	5322 100 10141
R 2409	71,5K	1	MR25	5322 116 54685
R 2411	226K	1	MR25	5322 116 54729
R 2412	10K	20	0.75W	5322 100 10141
R 2413	18,7K	1	MR25	5322 116 50558
R 2414	10K	20	0.75W	5322 100 10141
R 2417	82,5K	1	MR25	5322 116 54689
R 2418	6,81K	1	MR25	5322 116 54012
R 2419	10K	20	0.75W	5322 100 10141
R 2422	8,25K	1	MR25	5322 116 54558
R 2423	10K	20	0.75W	5322 100 10141
R 2424	12,7K	1	MR25	5322 116 50443
R 2426	21,5K	1	MR25	5322 116 50451
R 2427	10K	20	0.75W	5322 100 10141
R 2428	12,7K	1	MR25	5322 116 50443
R 2429	10K	20	0.75W	5322 100 10141
R 2432	12,7K	1	MR25	5322 116 50443
R 2433	2,74K	1	MR25	5322 116 50636
R 2439	5,62K	1	MR25	4822 116 51281
R 2442	100	1	MR25	5322 116 54469
R 2443	100	1	MR25	5322 116 54469
R 2444	4,75K	1	MR25	5322 116 54008
R 2447	100K	1	MR25	4822 116 51268

POSNR	DESCRIPTION			ORDERING CODE
R 2448	100	1	MR25	5322 116 54469
R 2449	100	1	MR25	5322 116 54469
R 2452	100	1	MR25	5322 116 54469
R 2453	100	1	MR25	5322 116 54469
R 2454	133K	1	MR25	5322 116 54708
R 2457	2,61K	1	MR25	5322 116 50671
R 2458	15,4K	1	MR25	5322 116 50479
R 2459	226K	1	MR25	5322 116 54729
R 2460	33,2K	1	MR25	4822 116 51259
R 2461	27,4K	1	MR25	5322 116 50559
R 2462	121K	1	MR25	5322 116 54704
R 2463	100	1	MR25	5322 116 54469
R 2464	301	1	MR25	5322 116 54508
R 2466	4,64K	1	MR25	5322 116 50484
R 2467	56,2K	1	MR25	4822 116 51264
R 2468	100	1	MR25	5322 116 54469
R 2469	100	1	MR25	5322 116 54469
R 2471	22,6K	1	MR25	5322 116 50481
R 2472	100	1	MR25	5322 116 54469
R 2473	100	1	MR25	5322 116 54469
R 2474	100	1	MR25	5322 116 54469
R 2478	1,5M	10	CR37	4822 110 53192
R 2479	100	1	MR25	5322 116 54469
R 2482	1,5M	10	CR37	4822 110 53192
R 2483	1,5M	10	CR37	4822 110 53192
R 2484	5,62K	1	MR25	4822 116 51281
R 2486	5,62K	1	MR25	4822 116 51281
R 2487	22,6K	1	MR25	5322 116 50481
R 2488	40,2K	1	MR25	5322 116 54665
R 2489	10K	1	MR25	4822 116 51253
R 2491	100	1	MR25	5322 116 54469
R 2492	100	1	MR25	5322 116 54469
R 2493	100	1	MR25	5322 116 54469
R 2494	1,5M	10	CR37	4822 110 53192
R 2496	2,26K	1	MR25	5322 116 50675
R 2497	6,49K	1	MR25	5322 116 54603
R 2498	3,01K	1	MR25	4822 116 51246
R 2499	4,02K	1	MR25	5322 116 55448
R 2502	61,9K	1	MR25	5322 116 50872
R 2503	100	1	MR25	5322 116 54469
R 2504	100	1	MR25	5322 116 54469
R 2507	100	1	MR25	5322 116 54469
R 2508	100	1	MR25	5322 116 54469
R 2509	100	1	MR25	5322 116 54469
R 2512	27,4K	1	MR25	5322 116 50559
R 2513	237K	1	MR25	5322 116 54732
R 2514	100	1	MR25	5322 116 54469
R 2515	100K	1	MR25	4822 116 51268
R 2516	5,11K	1	MR25	5322 116 54595
R 2517	100	1	MR25	5322 116 54469
R 2518	46,4K	1	MR25	5322 116 50557
R 2519	100K	1	MR25	4822 116 51268
R 2521	12,1K	1	MR25	5322 116 50572
R 2522	10K	1	MR25	4822 116 51253
R 2523	100K	20	0.75W	5322 100 10142
R 2524	71,5K	1	MR25	5322 116 54685
R 2526	30,1K	1	MR25	5322 116 54655
R 2527	100	1	MR25	5322 116 54469
R 2528	147K	1	MR25	5322 116 54712
R 2529	147K	1	MR25	5322 116 54712
R 2531	2,49K	1	MR25	5322 116 50581
R 2532	4,75K	1	MR25	5322 116 54008
R 2533	12,1K	1	MR25	5322 116 50572
R 2534	100	1	MR25	5322 116 54469
R 2535	1K	1	MR25	5322 116 54549

POSNR	DESCRIPTION			ORDERING CODE
R 2536	4,75K	1	MR25	5322 116 54008
R 2537	100	1	MR25	5322 116 54469
R 2538	133K	1	MR25	5322 116 54708
R 2539	2,37K	1	MR25	5322 116 54576
R 2541	4,75K	1	MR25	5322 116 54008
R 2542	12,1K	1	MR25	5322 116 50572
R 2543	100	1	MR25	5322 116 54469
R 2544	33,2K	1	MR25	4822 116 51259
R 2545	27,4K	1	MR25	5322 116 50559
R 2546	10	1	MR25	5322 116 50452
R 2547	15,4K	1	MR25	5322 116 50479
R 2548	90,9K	1	MR25	5322 116 54694
R 2549	2,2K	20	0.75W	5322 100 10144
R 2551	4	20	1W	4822 116 30041
R 2562	1K	1	MR25	5322 116 54549
R 2563	100	1	MR25	5322 116 54469
R 2564	100	1	MR25	5322 116 54469
R 2566	10	1	MR25	5322 116 50452
R 2568	22,6	1	MR25	5322 116 50491
R 2576	12,7K	1	MR25	5322 116 50443
R 2577	10K	20	0.75W	5322 100 10141
R 2578	8,25K	1	MR25	5322 116 54558
V 1	L14–140GH/95	PH		5322 131 24053
V 2	CQY24B-III	PH		4822 130 31144
V 3	CQY24B-III	PH		4822 130 31144
V 4	CQY24B-III	PH		4822 130 31144
V 5	CQY24B-III	PH		4822 130 31144
V 6	CQY24B-III	PH		4822 130 31144
V 7	CQY24B-III	PH		4822 130 31144
V 101	BAV45	PH		5322 130 34037
V 102	BFT46	PH		5322 130 44797
V 103	BFT25R	PH		5322 130 44459
V 104	BFR92	PH		5322 130 44178
V 151	BAV45	PH		5322 130 34037
V 152	BFT46	PH		5322 130 44797
V 153	BFT25	PH		5322 130 44458
V 154	BFR92R	PH		5322 130 44606
V 201	BAW62	PH		4822 130 30613
V 202	BAW62	PH		4822 130 30613
V 203	BFT92	PH		5322 130 44711
V 204	BFT92R	PH		5322 130 44713
V 206	BAV70	PH		5322 130 34331
V 207	BAV70	PH		5322 130 34331
V 208	BZX75-C1V4	PH		4822 130 34047
V 209	BAW62	PH		4822 130 30613
V 211	BAW62	PH		4822 130 30613
V 212	BAW62	PH		4822 130 30613
V 213	BAW62	PH		4822 130 30613
V 214	BCW33	PH		5322 130 44337
V 216	BCW30	PH		5322 130 44335
V 220	BAW62	PH		4822 130 30613
V 221	BAW62	PH		4822 130 30613
V 301	BAW62	PH		4822 130 30613
V 302	BAW62	PH		4822 130 30613
V 303	BFT92	PH		5322 130 44711
V 304	BFT92R	PH		5322 130 44713
V 306	BAV70	PH		5322 130 34331
V 307	BAV70	PH		5322 130 34331

POSNR		DESCRIPTION		ORDERING CODE
V	308	BZX75-C1V4	PH	4822 130 34047
V	309	BAW62	PH	4822 130 30613
V	311	BAW62	PH	4822 130 30613
V	312	BAW62	PH	4822 130 30613
V	313	BAW62	PH	4822 130 30613
V	314	BCW33R	PH	5322 130 44342
V	316	BCW30R	PH	5322 130 44341
V	320	BAW62	PH	4822 130 30613
V	321	BAW62	PH	4822 130 30613
V	401	BCW33	PH	5322 130 44337
V	402	BZX79-C5V1	PH	4822 130 34233
V	403	BAV70	PH	5322 130 34331
V	404	BAV70	PH	5322 130 34331
V	406	BZX75-C1V4	PH	4822 130 34047
V	407	BCW30	PH	5322 130 44335
V	408	BCW33	PH	5322 130 44337
V	409	BCW33	PH	5322 130 44337
V	451	BCW33R	PH	5322 130 44342
V	452	BZX79-C5V1	PH	4822 130 34233
V	453	BAV70	PH	5322 130 34331
V	454	BAV70	PH	5322 130 34331
V	456	BZX75-C1V4	PH	4822 130 34047
V	457	BCW30R	PH	5322 130 44341
V	458	BCW33R	PH	5322 130 44342
V	500	BAW62	PH	4822 130 30613
V	501	BCW30R	PH	5322 130 44341
V	502	BFT92R	PH	5322 130 44713
V	503	BCW30	PH	5322 130 44335
V	504	BFT92	PH	5322 130 44711
V	506	BCW33R	PH	5322 130 44342
V	507	BAW62	PH	4822 130 30613
V	601	BFT92R	PH	5322 130 44713
V	602	BFT92	PH	5322 130 44711
V	603	BC549C	PH	4822 130 44246
V	604	BAW62	PH	4822 130 30613
V	606	BC549C	PH	4822 130 44246
V	607	BC549C	PH	4822 130 44246
V	608	BC559B	PH	4822 130 44358
V	609	BBY31	PH	5322 130 34689
V	611	BBY31	PH	5322 130 34689
V	612	BZX75-C3V6	PH	4822 130 30765
V	614	BZX87-C5V6	PH	5322 130 34898
V	701	BC264A	PH	5322 130 44476
V	702	BC559B	PH	4822 130 44358
V	703	BC559B	PH	4822 130 44358
V	704	BC559B	PH	4822 130 44358
V	705	BZX75-C2V1	PH	4822 130 34049
V	706	BC549C	PH	4822 130 44246
V	707	BAW62	PH	4822 130 30613
V	708	BAW62	PH	4822 130 30613
V	709	BAW62	PH	4822 130 30613
V	711	BFY90	PH	4822 130 40493
V	712	BFY90	PH	4822 130 40493
V	801	BC559B	PH	4822 130 44358
V	802	BAW56	PH	5322 130 30691
V	803	BFT92	PH	5322 130 44711
V	804	BFT92R	PH	5322 130 44713
V	806	BFR92	PH	5322 130 44178
V	807	BF324	PH	4822 130 41448
V	808	BAW62	PH	4822 130 30613
V	809	BAW56	PH	5322 130 30691
V	811	BAW62	PH	4822 130 30613
V	812	BAW56	PH	5322 130 30691
V	813	BFT92R	PH	5322 130 44713
V	814	BFR92R	PH	5322 130 44606
V	815	BAX12A	PH	5322 130 34605

POSNR		DESCRIPTION		ORDERING CODE
V	816	BFR92	PH	5322 130 44178
V	817	BFR92	PH	5322 130 44178
V	818	BFR92R	PH	5322 130 44606
V	819	BAV99	PH	5322 130 34337
V	821	BFR92	PH	5322 130 44178
V	822	BFR92R	PH	5322 130 44606
V	823	BFR92R	PH	5322 130 44606
V	824	BFR92	PH	5322 130 44178
V	826	BFT92R	PH	5322 130 44713
V	827	BFT92R	PH	5322 130 44713
V	828	BAW62	PH	4822 130 30613
V	829	BC549C	PH	4822 130 44246
V	831	BAW62	PH	4822 130 30613
V	901	BAW62	PH	4822 130 30613
V	902	BC549C	PH	4822 130 44246
V	903	BSX20	PH	5322 130 40417
V	904	BAW62	PH	4822 130 30613
V	906	BSX20	PH	5322 130 40417
V	907	BSX20	PH	5322 130 40417
V	908	BC549C	PH	4822 130 44246
V	909	BAW62	PH	4822 130 30613
V	910	BAW62	PH	4822 130 30613
V	911	BC549C	PH	4822 130 44246
V	912	BAW62	PH	4822 130 30613
V	913	BC559B	PH	4822 130 44358
V	914	BC559B	PH	4822 130 44358
V	916	BC549C	PH	4822 130 44246
V	917	BAW62	PH	4822 130 30613
V	918	BCY59	PH	5322 130 44073
V	919	BC549C	PH	4822 130 44246
V	921	BAW62	PH	4822 130 30613
V	922	BC549C	PH	4822 130 44246
V	923	BC549C	PH	4822 130 44246
V	924	BC559B	PH	4822 130 44358
V	926	BAW62	PH	4822 130 30613
V	927	BAW62	PH	4822 130 30613
V	928	BSX20	PH	5322 130 40417
V	929	BF324		4822 130 41448
V	930	BAW62	PH	4822 130 30613
V	931	BF324	PH	4822 130 41448
V	932	BAW62	PH	4822 130 30613
V	933	BAW62	PH	4822 130 30613
V	934	BC559B	PH	4822 130 44358
V	935	BZX79-C4V7	PH	4822 130 34174
V	936	BC549C	PH	4822 130 44246
V	937	BC549C	PH	4822 130 44246
V	938	BAW62	PH	4822 130 30613
V	939	BC559B	PH	4822 130 44358
V	940	BAW62	PH	4822 130 30613
V	941	BAW62	PH	4822 130 30613
V	942	BAW62	PH	4822 130 30613
V	943	BAW62	PH	4822 130 30613
V	944	BF324	PH	4822 130 41448
V	945	BC549C	PH	4822 130 44246
V	946	BAW62	PH	4822 130 30613
V	948	BC549C	PH	4822 130 44246

POSNR	DESCRIPTION		ORDERING CODE
V 949	BC549C	PH	4822 130 44246
V 950	BAW62	PH	4822 130 30613
V 951	BC549C	PH	4822 130 44246
V 952	BC549C	PH	4822 130 44246
V 953	BAW62	PH	4822 130 30613
V 954	BC559B	PH	4822 130 44358
V 955	BAW62	PH	4822 130 30613
V 956	BC549C	PH	4822 130 44246
V 957	BAW62	PH	4822 130 30613
V 958	BAW62	PH	4822 130 30613
V 959	BC559B	PH	4822 130 44358
V 960	BAW62	PH	4822 130 30613
V 961	BC559B	PH	4822 130 44358
V 962	BAW62	PH	4822 130 30613
V 963	BAW62	PH	4822 130 30613
V 964	BC549C	PH	4822 130 44246
V 965	BAW62	PH	4822 130 30613
V 971	BAW62	PH	4822 130 30613
V 972	BAW62	PH	4822 130 30613
V 973	BC549C	PH	4822 130 44246
V 1101	BC264A	PH	5322 130 44476
V 1102	BC559B	PH	4822 130 44358
V 1103	BAW62	PH	4822 130 30613
V 1104	BFY90	PH	4822 130 40493
V 1201	BF324	PH	4822 130 41448
V 1202	BAW56	PH	5322 130 30691
V 1203	BFT92R	PH	5322 130 44713
V 1204	BFT92	PH	5322 130 44711
V 1206	BFR92R	PH	5322 130 44606
V 1207	BAW62	PH	4822 130 30613
V 1208	BAW56	PH	5322 130 30691
V 1209	BAW56	PH	5322 130 30691
V 1211	BAW62	PH	4822 130 30613
V 1212	BFT92	PH	5322 130 44711
V 1213	BFR92R	PH	5322 130 44606
V 1214	BFR92	PH	5322 130 44178
V 1216	BAV99	PH	5322 130 34337
V 1217	BFR92	PH	5322 130 44178
V 1218	BFR92R	PH	5322 130 44606
V 1219	BFR92R	PH	5322 130 44606
V 1221	BFT92	PH	5322 130 44711
V 1222	BFR92	PH	5322 130 44178
V 1223	BFT92	PH	5322 130 44711
V 1224	BAW62	PH	4822 130 30613
V 1226	BAW62	PH	4822 130 30613
V 1227	BC549C	PH	4822 130 44246
V 1300	BC549C	PH	4822 130 44246
V 1301	BAW62	PH	4822 130 30613
V 1302	BAW62	PH	4822 130 30613
V 1303	BAW62	PH	4822 130 30613
V 1304	BF324	PH	4822 130 41448
V 1305	BAW62	PH	4822 130 30613
V 1306	BAW62	PH	4822 130 30613
V 1307	BC549C	PH	4822 130 44246
V 1308	BSX20	PH	5322 130 40417
V 1309	BSX20	PH	5322 130 40417
V 1310	BC549C	PH	4822 130 44246
V 1311	BSX20	PH	5322 130 40417
V 1312	BC549C	PH	4822 130 44246
V 1313	BAW62	PH	4822 130 30613
V 1314	BC549C	PH	4822 130 44246
V 1316	BAW62	PH	4822 130 30613
V 1317	BC559B	PH	4822 130 44358
V 1318	BC559B	PH	4822 130 44358
V 1319	BC549C	PH	4822 130 44246

POSNR	DESCRIPTION		ORDERING CODE
V 1321	BAW62	PH	4822 130 30613
V 1322	BCY59	PH	5322 130 44073
V 1323	BC549C	PH	4822 130 44246
V 1324	BAW62	PH	4822 130 30613
V 1326	BC549C	PH	4822 130 44246
V 1327	BC549C	PH	4822 130 44246
V 1328	BC559B	PH	4822 130 44358
V 1329	BAW62	PH	4822 130 30613
V 1331	BAW62	PH	4822 130 30613
V 1332	BAW62	PH	4822 130 30613
V 1336	BC559B	PH	4822 130 44358
V 1337	BAW62	PH	4822 130 30613
V 1338	BAW62	PH	4822 130 30613
V 1339	BC549C	PH	4822 130 44246
V 1501	BC549C	PH	4822 130 44246
V 1502	BC559B	PH	4822 130 44358
V 1503	BAW62	PH	4822 130 30613
V 1504	BAW62	PH	4822 130 30613
V 1506	BC559B	PH	4822 130 44358
V 1507	BAW62	PH	4822 130 30613
V 1508	BAW62	PH	4822 130 30613
V 1509	BC549C	PH	4822 130 44246
V 1511	BC559B	PH	4822 130 44358
V 1512	BC559B	PH	4822 130 44358
V 1513	BAW62	PH	4822 130 30613
V 1514	BAW62	PH	4822 130 30613
V 1515	BAW62	PH	4822 130 30613
V 1516	BC559B	PH	4822 130 44358
V 1517	BC559B	PH	4822 130 44358
V 1518	BAW62	PH	4822 130 30613
V 1519	BC549C	PH	4822 130 44246
V 1520	BC549C	PH	4822 130 44246
V 1521	BC559B	PH	4822 130 44358
V 1522	BAW62	PH	4822 130 30613
V 1523	BZX79-C8V2	PH	4822 130 34382
V 1524	BC559B	PH	4822 130 44358
V 1526	BAW62	PH	4822 130 30613
V 1527	BC559	PH	4822 130 40963
V 1528	BAW62	PH	4822 130 30613
V 1529	BAW62	PH	4822 130 30613
V 1552	BZX79-B5V1	PH	4822 130 34233
V 1556	BAW62	PH	4822 130 30613
V 1557	BAW62	PH	4822 130 30613
V 1558	BAW62	PH	4822 130 30613
V 1559	BD135	PH	4822 130 40823
V 1561	BC559B	PH	4822 130 44358
V 1562	BD135	PH	4822 130 40823
V 1563	BAW62	PH	4822 130 30613
V 1564	BZX79-B6V2	PH	4822 130 34167
V 1566	BAW62	PH	4822 130 30613
V 1567	BD136	PH	4822 130 40712
V 1568	BD136	PH	4822 130 40712
V 1601	BSX20	PH	5322 130 40417
V 1651	BZX91	PH	5322 130 34397
V 1652	BZX79-C12	PH	4822 130 34197

POSNR	DESCRIPTION		ORDERING CODE
V 1654	BD436	PH	4822 130 40995
V 1656	BD435	PH	4822 130 40982
V 1657	BZX91	PH	5322 130 34397
V 1658	BZX79-C12	PH	4822 130 34197
V 1661	BD435	PH	4822 130 40982
V 1662	BD436	PH	4822 130 40995
V 1701	BSX20	PH	5322 130 40417
V 1702	BSX20	PH	5322 130 40417
V 1703	BC549C	PH	4822 130 44246
V 1704	BC559B	PH	4822 130 44358
V 1706	BF422	PH	4822 130 44108
V 1707	BF423	PH	4822 130 41646
V 1708	BF423	PH	4822 130 41646
V 1709	BF422	PH	4822 130 44108
V 1711	BAW62	PH	4822 130 30613
V 1712	BZX75-C2V1	PH	4822 130 34049
V 1713	BAW62	PH	4822 130 30613
V 1714	BF422	PH	4822 130 44108
V 1716	BF423	PH	4822 130 41646
V 1717	BF423	PH	4822 130 41646
V 1718	BF422	PH	4822 130 44108
V 1719	BZX79-C5V6	PH	4822 130 34173
V 1721	BZX79-C5V6	PH	4822 130 34173
V 1722	BC549C	PH	4822 130 44246
V 1723	BC549C	PH	4822 130 44246
V 1724	BC559B	PH	4822 130 44358
V 1726	BC559B	PH	4822 130 44358
V 1801	BY224-600	PH	5322 130 34761
V 1802	BZX79-C12	PH	4822 130 34197
V 1803	BUX86	PH	5322 130 44718
V 1804	BC549C	PH	4822 130 44246
V 1806	BU208	PH	5322 130 44917
V 1807	BAX12	PH	5322 130 34605
V 1808	BY208-1000	PH	4822 130 31051
V 1809	BY208-1000	PH	4822 130 31051
V 1811	BY208-1000	PH	4822 130 31051
V 1812	BC549C	PH	4822 130 44246
V 1813	BZX79-C12	PH	4822 130 34197
V 1814	BAW62	PH	4822 130 30613
V 1816	BY206	PH	4822 130 30839
V 1817	BY206	PH	4822 130 30839
V 1818	BY206	PH	4822 130 30839
V 1819	BY206	PH	4822 130 30839
V 1826	BYX55-600	PH	4822 130 30817
V 1827	BY206	PH	4822 130 30839
V 1828	BY206	PH	4822 130 30839
V 1829	BYX55-600	PH	4822 130 30817
V 1831	BYX55-600	PH	4822 130 30817
V 1832	BYX55-600	PH	4822 130 30817
V 1833	BYX55-600	PH	4822 130 30817
V 1834	BYX55-600	PH	4822 130 30817
V 1836	BY206	PH	4822 130 30839
V 1837	BY206	PH	4822 130 30839
V 1838	BY206	PH	4822 130 30839
V 1839	BY206	PH	4822 130 30839
V 1841	BAW62	PH	4822 130 30613
V 1842	H11A550	GE	5322 130 94015
V 1843	BC549C	PH	4822 130 44246
V 1844	BC549C	PH	4822 130 44246
V 1846	BC549C	PH	4822 130 44246
V 1847	BZX75-C1V4	PH	4822 130 34047
V 1851	BY409	PH	5322 130 34594
V 1852	BY409	PH	5322 130 34594
V 1853	BY409	PH	5322 130 34594
V 1854	BY409	PH	5322 130 34594

POSNR	DESCRIPTION		ORDERING CODE
V 1876	BY206	PH	4822 130 30839
V 1877	BY206	PH	4822 130 30839
V 1878	BY206	PH	4822 130 30839
V 1879	BY206	PH	4822 130 30839
V 1881	BY206	PH	4822 130 30839
V 1882	BY206	PH	4822 130 30839
V 1883	BY206	PH	4822 130 30839
V 1884	BY206	PH	4822 130 30839
V 1886	BY206	PH	4822 130 30839
V 1887	BY206	PH	4822 130 30839
V 1901	BZX79-C5V6	PH	4822 130 34173
V 2001	BC559B	PH	4822 130 44358
V 2002	BSX20	PH	5322 130 40417
V 2003	BSX20	PH	5322 130 40417
V 2004	BC559B	PH	4822 130 44358
V 2006	BAW62	PH	4822 130 30613
V 2007	BF324	PH	4822 130 41448
V 2008	BF324	PH	4822 130 41448
V 2012	BF423	PH	4822 130 41646
V 2013	BF422	PH	4822 130 44108
V 2014	BAW62	PH	4822 130 30613
V 2016	BF422	PH	4822 130 44108
V 2019	BZX79-C5V6	PH	4822 130 34173
V 2021	BSX20	PH	5322 130 40417
V 2023	BF423	PH	4822 130 41646
V 2024	BAW62	PH	4822 130 30613
V 2026	BF422	PH	4822 130 44108
V 2028	BF422	PH	4822 130 44108
V 2029	BZX79-C5V6	PH	4822 130 34173
V 2032	BSX20	PH	5322 130 40417
V 2033	BF422	PH	4822 130 44108
V 2034	BAW62	PH	4822 130 30613
V 2036	BAX12	PH	5322 130 34605
V 2037	BF422	PH	4822 130 44108
V 2038	BC559B	PH	4822 130 44358
V 2039	BF423	PH	4822 130 41646
V 2040	BF423	PH	4822 130 41646
V 2041	BF423	PH	4822 130 41646
V 2042	BF423	PH	4822 130 41646
V 2043	BF423	PH	4822 130 41646
V 2056	BC549C	PH	4822 130 44246
V 2057	BC559B	PH	4822 130 44358
V 2058	BYX10	PH	4822 130 30195
V 2063	BC549C	PH	4822 130 44246
V 2064	BC559B	PH	4822 130 44358
V 2071	BZX61-C180	PH	5322 130 34841
V 2072	BZX61-C180	PH	5322 130 34841
V 2073	BUX86	PH	5322 130 44718
V 2074	BF422	PH	4822 130 44108
V 2075	BF422	PH	4822 130 44108
V 2076	BAX12	PH	5322 130 34605
V 2077	BAX12	PH	5322 130 34605
V 2079	BYW54	PH	5322 130 34919
V 2080	BZX79-C7V5	PH	4822 130 30861
V 2081	BY409	PH	5322 130 34594

POSNR	DESCRIPTION		ORDERING CODE
V 2082	BY409	PH	5322 130 34594
V 2083	BY409	PH	5322 130 34594
V 2107	BC557	PH	4822 130 44256
V 2201	BAW62	PH	4822 130 30613
V 2202	BAW62	PH	4822 130 30613
V 2203	BAW62	PH	4822 130 30613
V 2205	BAW62	PH	4822 130 30613
V 2206	BAW62	PH	4822 130 30613
V 2207	BAW62	PH	4822 130 30613
V 2208	BAW62	PH	4822 130 30613
V 2209	BAW62	PH	4822 130 30613
V 2212	BAW62	PH	4822 130 30613
V 2213	BC549C	PH	4822 130 44246
V 2214	BAW62	PH	4822 130 30613
V 2216	BC549C	PH	4822 130 44246
V 2217	BAW62	PH	4822 130 30613
V 2218	BAW62	PH	4822 130 30613
V 2219	BAW62	PH	4822 130 30613
V 2221	BAW62	PH	4822 130 30613
V 2222	BZX79-C5V6	PH	4822 130 34173
V 2223	BAW62	PH	4822 130 30613
V 2224	BAW62	PH	4822 130 30613
V 2226	BAW62	PH	4822 130 30613
V 2227	BAW62	PH	4822 130 30613
V 2228	BAW62	PH	4822 130 30613
V 2229	BAW62	PH	4822 130 30613
V 2230	BAW62	PH	4822 130 30613
V 2231	BAW62	PH	4822 130 30613
V 2232	BC549C	PH	4822 130 44246
V 2233	BAW62	PH	4822 130 30613
V 2234	BAW62	PH	4822 130 30613
V 2237	BC559B	PH	4822 130 44358
V 2239	BAW62	PH	4822 130 30613
V 2243	2N2894A	PH	5322 130 44127
V 2244	BSX20	PH	5322 130 40417
V 2251	BAW62	PH	4822 130 30613
V 2252	BAW62	PH	4822 130 30613
V 2253	BAW62	PH	4822 130 30613
V 2254	BAW62	PH	4822 130 30613
V 2256	BAW62	PH	4822 130 30613
V 2261	BAW62	PH	4822 130 30613
V 2262	BAW62	PH	4822 130 30613
V 2263	BAW62	PH	4822 130 30613
V 2266	BAW62	PH	4822 130 30613
V 2267	BAW62	PH	4822 130 30613
V 2402	BC559B	PH	4822 130 44358
V 2403	BC559B	PH	4822 130 44358
V 2404	BF422	PH	4822 130 44108
V 2407	BF423	PH	4822 130 41646
V 2408	BF422	PH	4822 130 44108
V 2409	BF422	PH	4822 130 44108
V 2412	BF422	PH	4822 130 44108
V 2413	BF423	PH	4822 130 41646
V 2414	BC559B	PH	4822 130 44358
V 2416	BC559B	PH	4822 130 44358
V 2417	BF422	PH	4822 130 44108
V 2418	BF422	PH	4822 130 44108
V 2419	BC549C	PH	4822 130 44246
V 2421	BUX86	PH	5322 130 44718
V 2422	BUX86	PH	5322 130 44718
V 2423	BAW62	PH	4822 130 30613
V 2424	BAW62	PH	4822 130 30613
V 2426	BUX86	PH	5322 130 44718
V 2427	BUX86	PH	5322 130 44718
V 2429	BYX10	PH	4822 130 30195

POSNR	DESCRIPTION		ORDERING CODE
V 2431	BF422	PH	4822 130 44108
V 2432	BAW62	PH	4822 130 30613
V 2433	BAW62	PH	4822 130 30613
V 2434	BYX10	PH	4822 130 30195
V 2436	BYX10	PH	4822 130 30195
V 2437	BC559B	PH	4822 130 44358
V 2438	BC559B	PH	4822 130 44358
V 2439	BF422	PH	4822 130 44108
V 2441	BAW62	PH	4822 130 30613
V 2442	BF422	PH	4822 130 44108
V 2443	BAW62	PH	4822 130 30613
V 2444	BF422	PH	4822 130 44108
V 2446	BF422	PH	4822 130 44108
V 2447	BAW62	PH	4822 130 30613
V 2448	BF422	PH	4822 130 44108
V 2449	BF422	PH	4822 130 44108
V 2451	BF422	PH	4822 130 44108
V 2452	BAW62	PH	4822 130 30613
V 2453	BD140	PH	4822 130 40824
V 2454	BZX79-C36	PH	4822 130 34368
V 2457	BZX79-C10	PH	4822 130 34297
V 2458	BF324	PH	4822 130 41448
V 2459	BAW62	PH	4822 130 30613
V 2461	BC549C	PH	4822 130 44246
V 2462	BC547	PH	4822 130 44257
V 2463	BAW62	PH	4822 130 30613
V 2464	BAW62	PH	4822 130 30613
V 2466	BZX79-C4V7	PH	4822 130 34174
V 2467	BC548C	PH	4822 130 44196

INTEGRATED CIRCUITS

POSNR	DESCRIPTION		ORDERING CODE
D 101	LM208H	SC	5322 209 85475
D 102	TF CIRCUIT		5322 116 94021
D 151	LM208H	SC	5322 209 85475
D 152	TF CIRCUIT		5322 116 94021
D 201	OQ 0012		5322 209 85484
D 202	OQ 0012		5322 209 85484
D 203	OQ 0012		5322 209 85484
D 301	OQ 0012		5322 209 85484
D 302	OQ 0012		5322 209 85484
D 303	OQ 0012		5322 209 85484
D 401	OQ 0012		5322 209 85484
D 451	OQ 0012		5322 209 85484
D 501	OQ 0012		5322 209 85484
D 601	OQ 0012		5322 209 85484
D 602	OM504		5322 216 54192
D 603	HIC-P5185	PH	5322 255 44246
D 701	LM208H	NS	5322 209 85475
D 801	LM208H	NS	5322 209 85475
D 802	GXB10104P	PH	5322 209 86012
D 901	10231BA	SC	5322 209 86003
D 902	GXB10102D	SC	5322 209 85955
D 903	LM308T	PH	5322 209 85475
D 904	LM308T	PH	5322 209 85475
D 906	UA741CN	SC	4822 209 80617
D 1101	LM208H	NS	5322 209 85475
D 1201	LM308T	PH	5322 209 85475
D 1301	LM308T	PH	5322 209 85475
D 1302	LM308T	PH	5322 209 85475
D 1303	CA3086	PH	5322 209 86236
D 1304	LM308T	PH	5322 209 85475
D 1551	TCA220	PH	5322 209 84386

POSNR	DESCRIPTION		ORDERING CODE
D 1552	TCA220	PH	5322 209 84386
D 1601	N74LS00N	SC	5322 209 84823
D 1602	N74LS02N	SC	5322 209 85312
D 1603	N74LS02N	SC	5322 209 85312
D 1604	N74LS76N	SC	5322 209 85527
D 1606	N74LS00N	SC	5322 209 84823
D 1607	N74LS00N	SC	5322 209 84823
D 1608	N74LS00N	SC	5322 209 84823
D 1609	N74LS76N	SC	5322 209 85527
D 1651	LM324N	SC	5322 209 85899
D 1801	TDA1060	PH	5322 209 85662
D 1901	UA709CH	SC	5322 209 84452
D 2201	HEF4073BP	PH	5322 209 14066
D 2202	HEF4049BP	PH	5322 209 14049
D 2203	HEF4011BP	PH	5322 209 14046
D 2204	HEF40175BP	PH	5322 209 14406
D 2207	HEF4011BP	PH	5322 209 14046
D 2208	HEF4013BP	PH	5322 209 10002
D 2209	HEF4081BP	PH	5322 209 14054
D 2211	HEF4081BP	PH	5322 209 14054
D 2212	HEF4049BP	PH	5322 209 14049
D 2213	HEF4050BP	PH	5322 209 14068
D 2214	HEF4011BP	PH	5322 209 14046
D 2216	HEF4013BP	PH	5322 209 10002
D 2217	HEF4049BP	PH	5322 209 14049
D 2221	LM324N	SC	5322 209 85899
D 2222	UA748N	SC	5322 209 86205
D 2223	HEF4104BP	PH	5322 209 14443
D 2224	HEF4073BP	PH	5322 209 14066
D 2226	HEF4049BP	PH	5322 209 14049
D 2227	HEF4047BP	PH	5322 209 14125
D 2228	HEF4049BP	PH	5322 209 14049
D 2229	HEF4013BP	PH	5322 209 10002
D 2231	HEF4081BP	PH	5322 209 14054
D 2401	HEF4066BP	PH	5322 209 14104
D 2402	HEF4066BP	PH	5322 209 14104
D 2403	HEF4066BP	PH	5322 209 14104
D 2406	LM324N	SC	5322 209 85899
F 1	T2A		4822 253 30025
K 1701			5322 280 24126
L 1801			5322 156 14076
L 1802			5322 156 14076
L 1803			5322 142 44026
L 1804			5322 281 64154
L 1806			5322 148 84041
L 1807			5322 152 24062
L 1811			4822 156 20663
L 1812			4822 156 20663
L 1813			4822 156 20663
L 1814			4822 156 20663
L 1816			5322 152 24067
L 1817			5322 152 24068
L 1876			5322 152 24071
L 1877			5322 152 24071
L 1878			5322 152 24071
S 1801			5322 277 24071
T 1801			5322 148 84039
T 1876			5322 146 24446

12. CIRCUIT DIAGRAMS AND PRINTED CIRCUIT BOARD LAY-OUTS

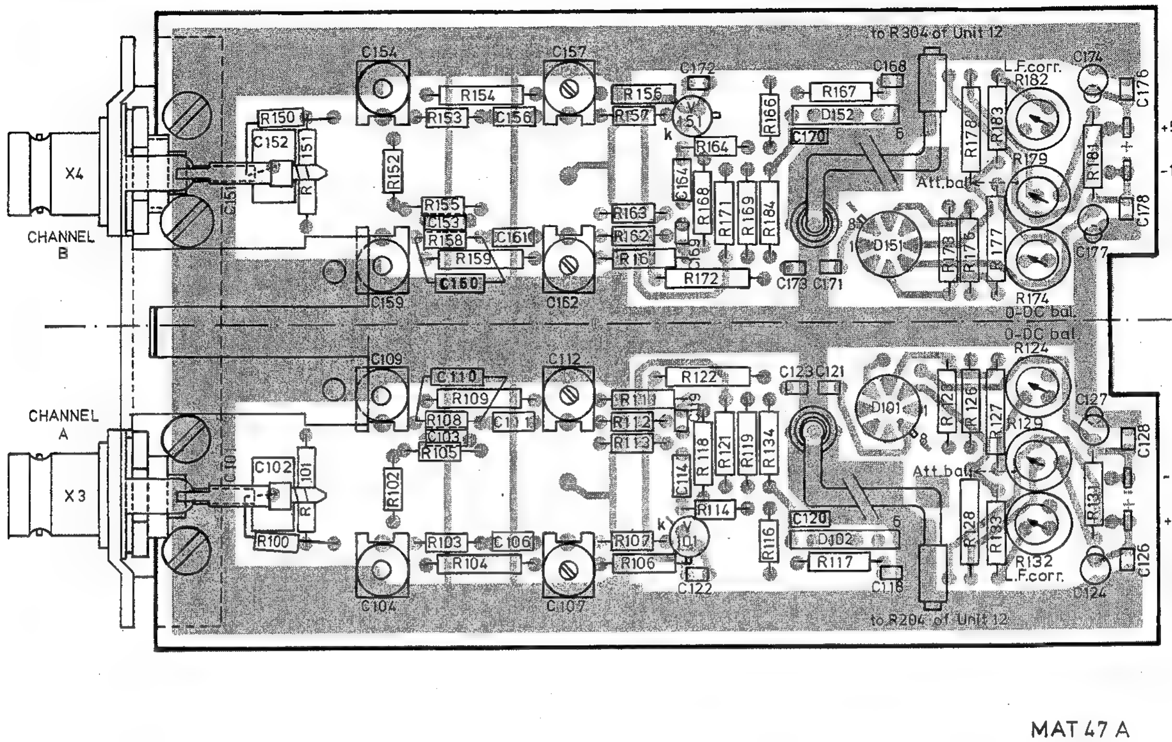


Fig. 12.1. Vertical attenuator (Unit 2), component side lay-out

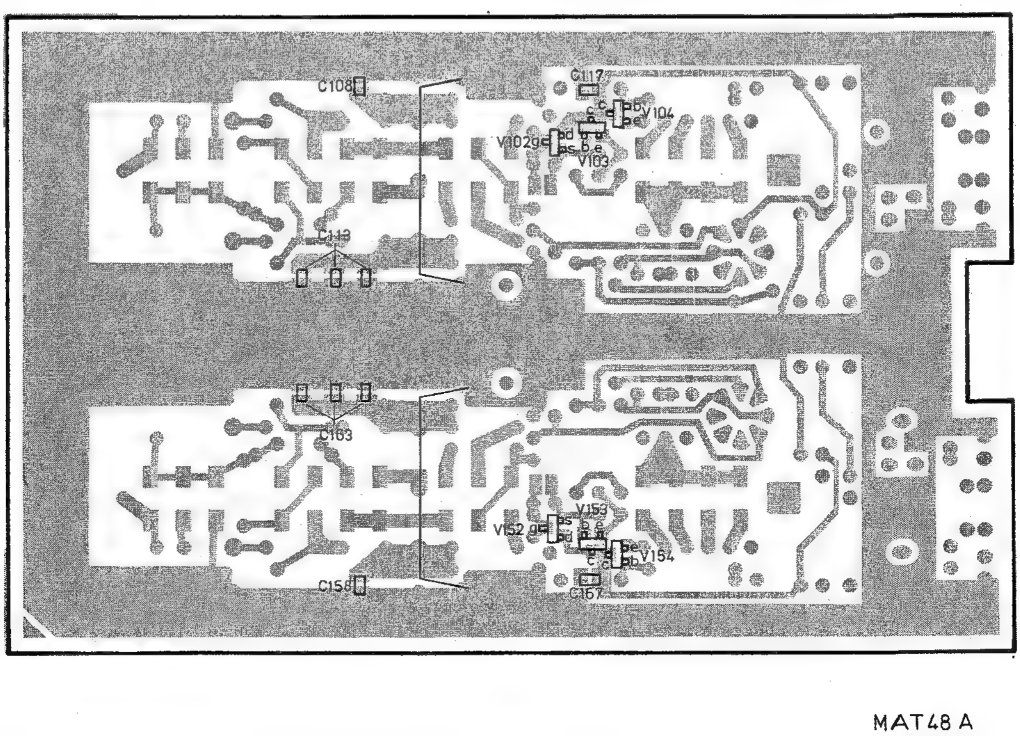


Fig. 12.2. Vertical attenuator (Unit 2), conductor lay-out

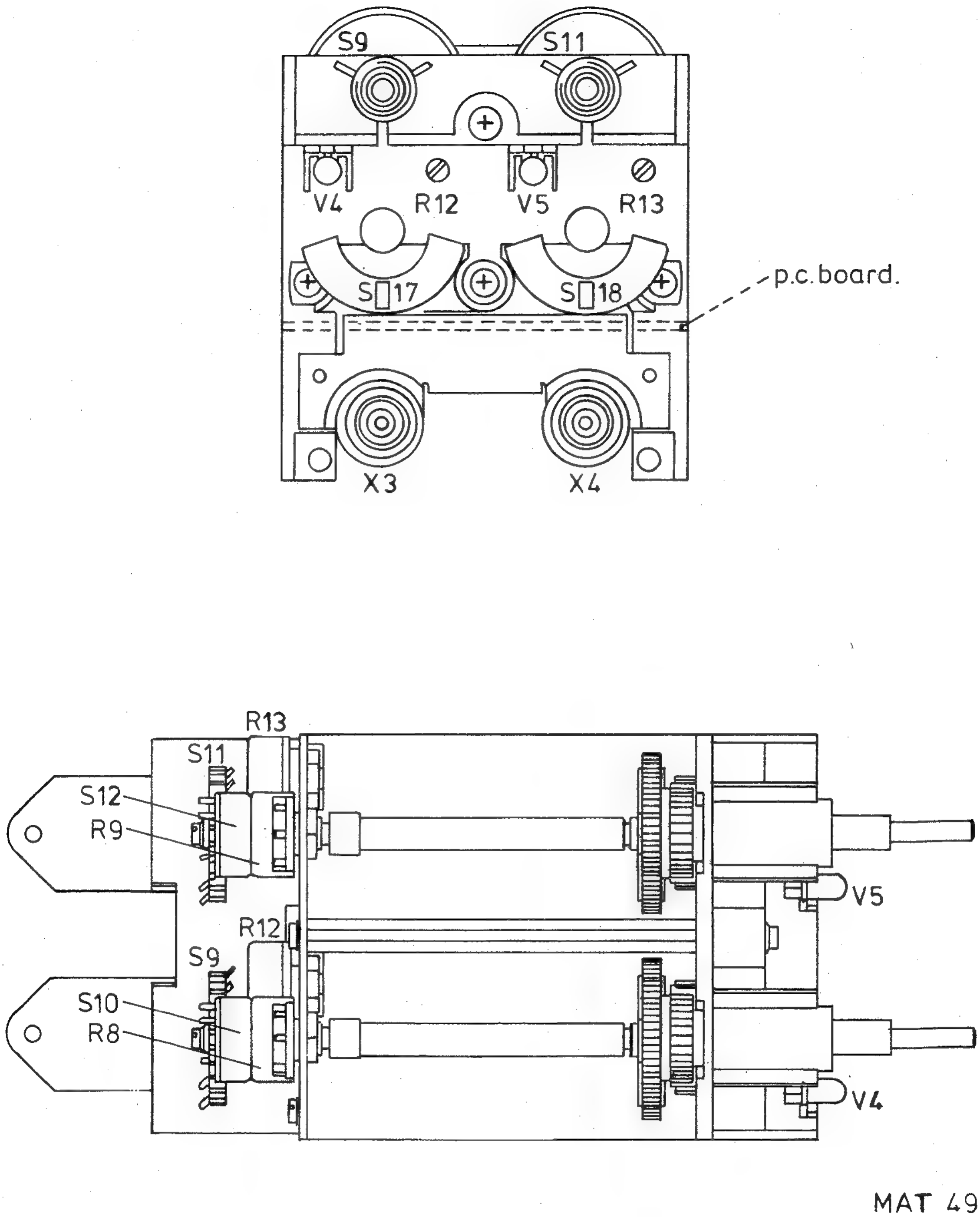


Fig. 12.3. Vertical attenuator (Unit 2), mechanical lay-out

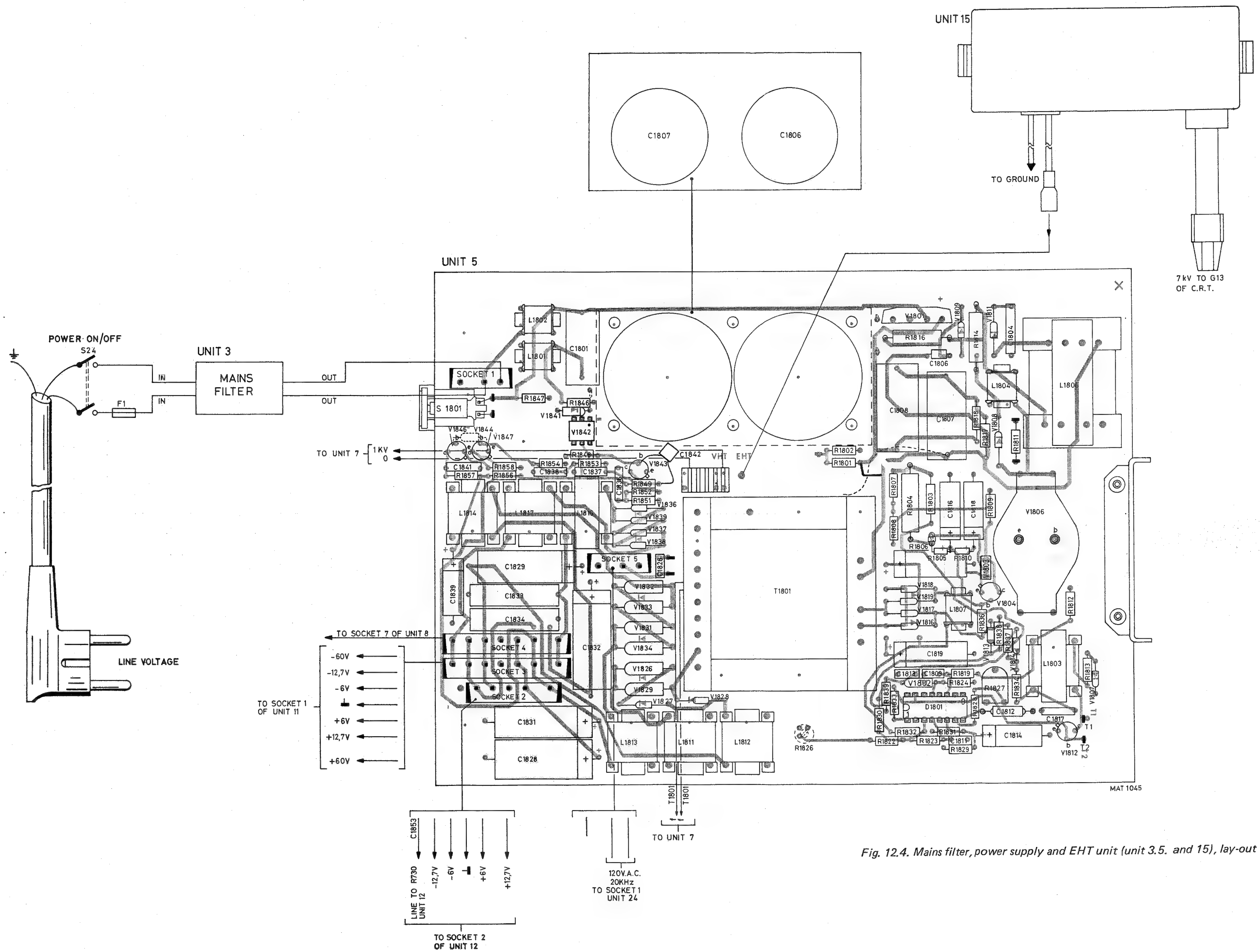


Fig. 12.4. Mains filter, power supply and EHT unit (unit 3.5. and 15), lay-out

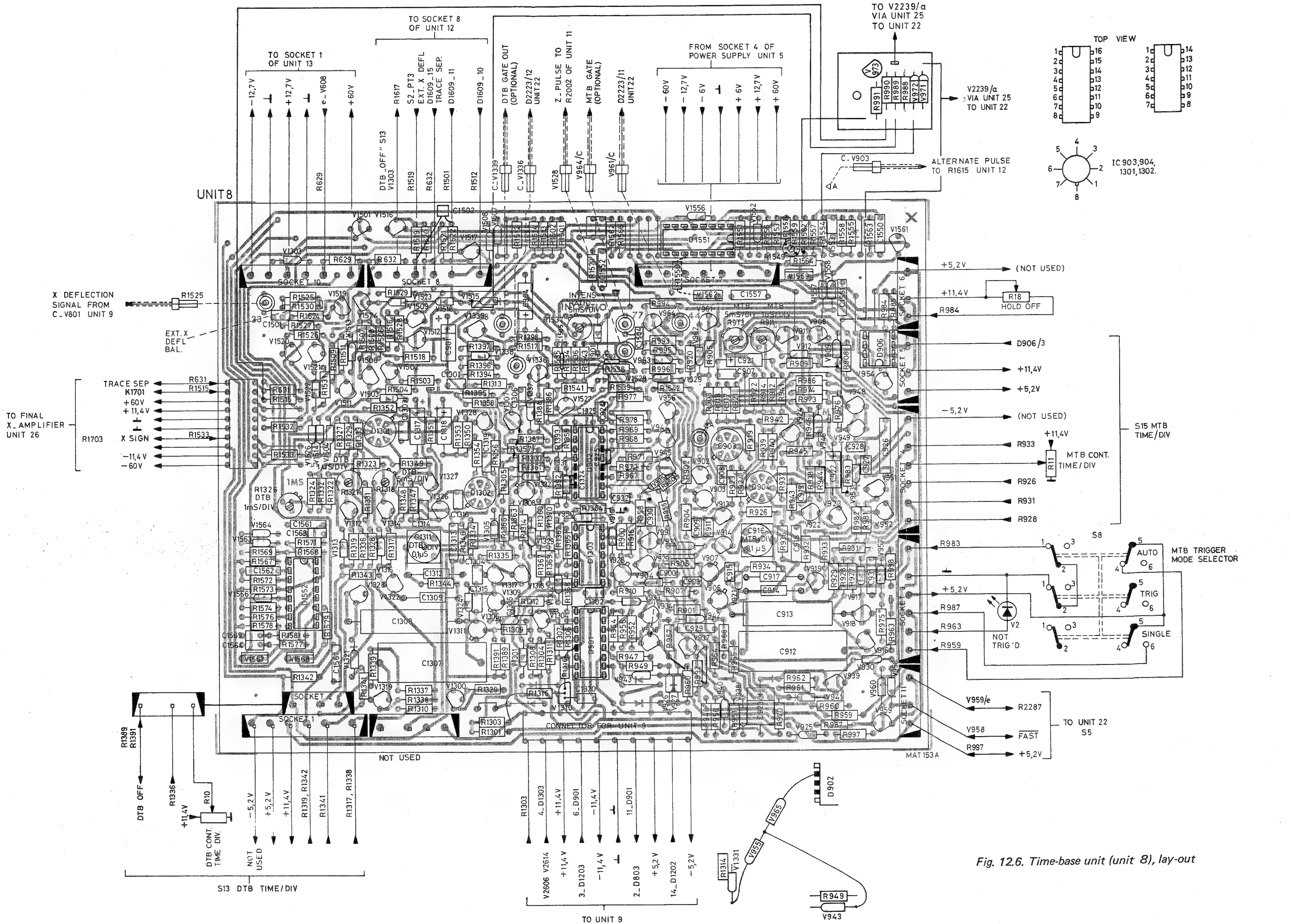


Fig. 12.6. Time-base unit (unit 8), lay-out

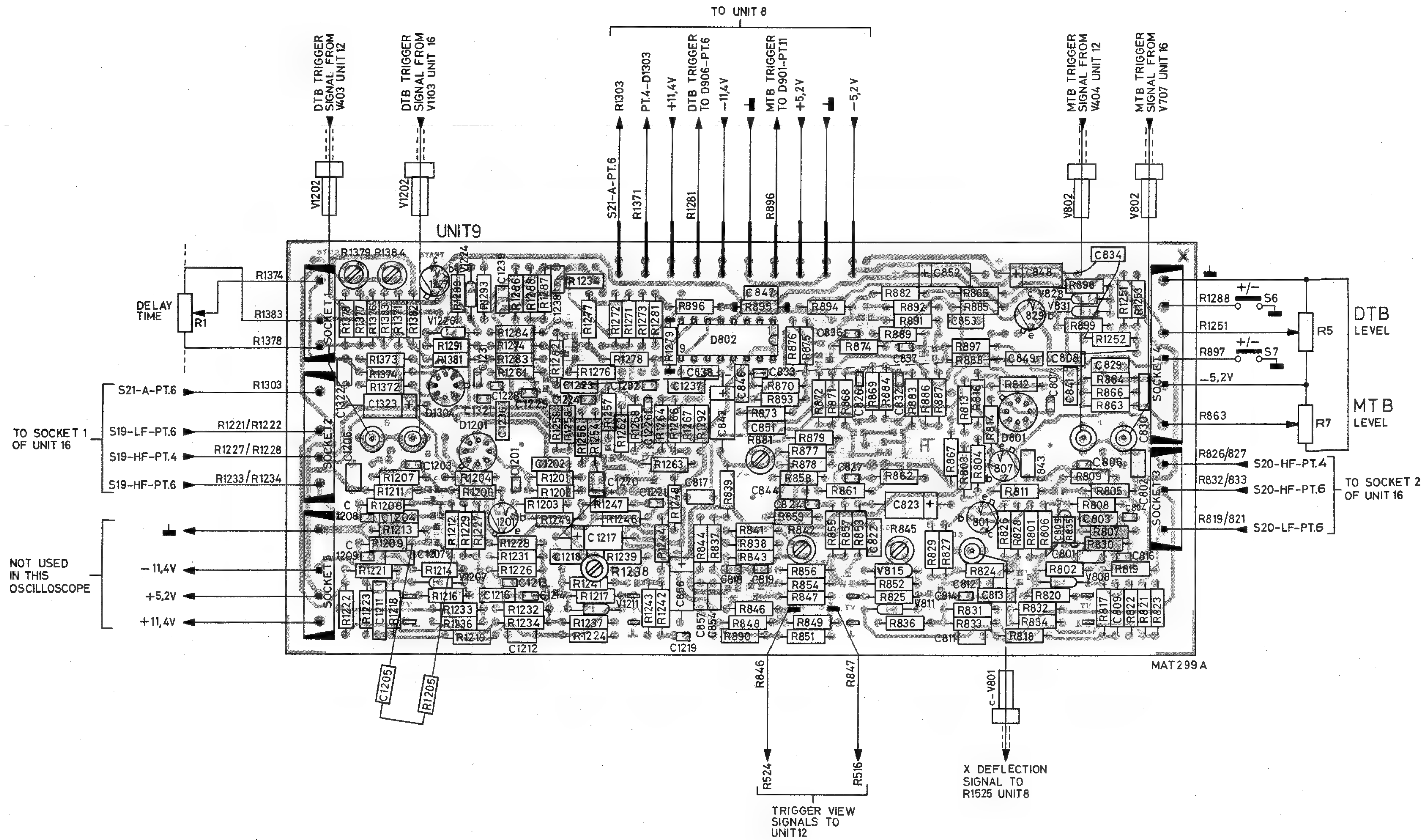


Fig. 12.7. Trigger amplifier (unit 9), lay-out

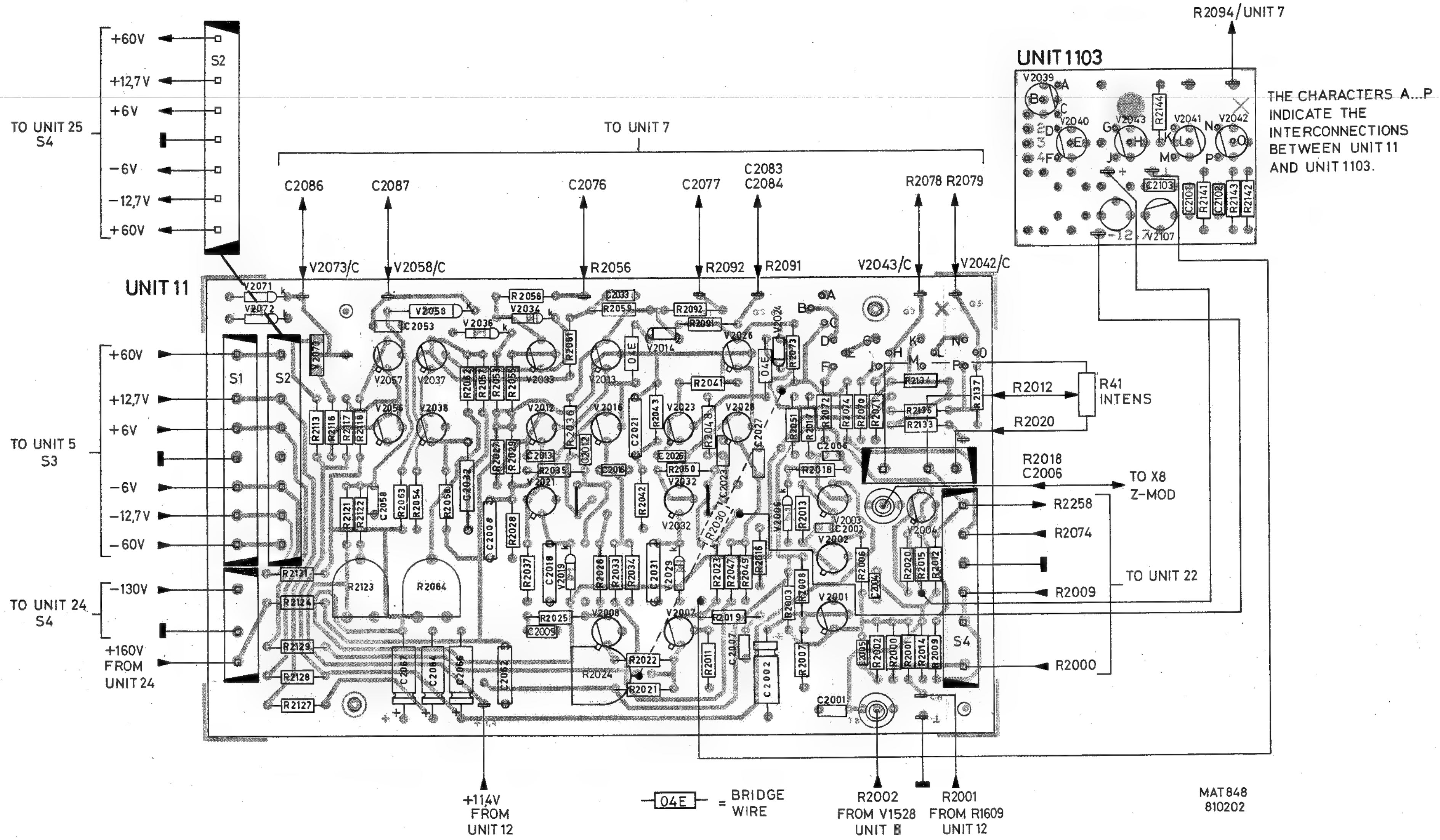


Fig. 12.8. Z-amplifier (unit 11), lay-out

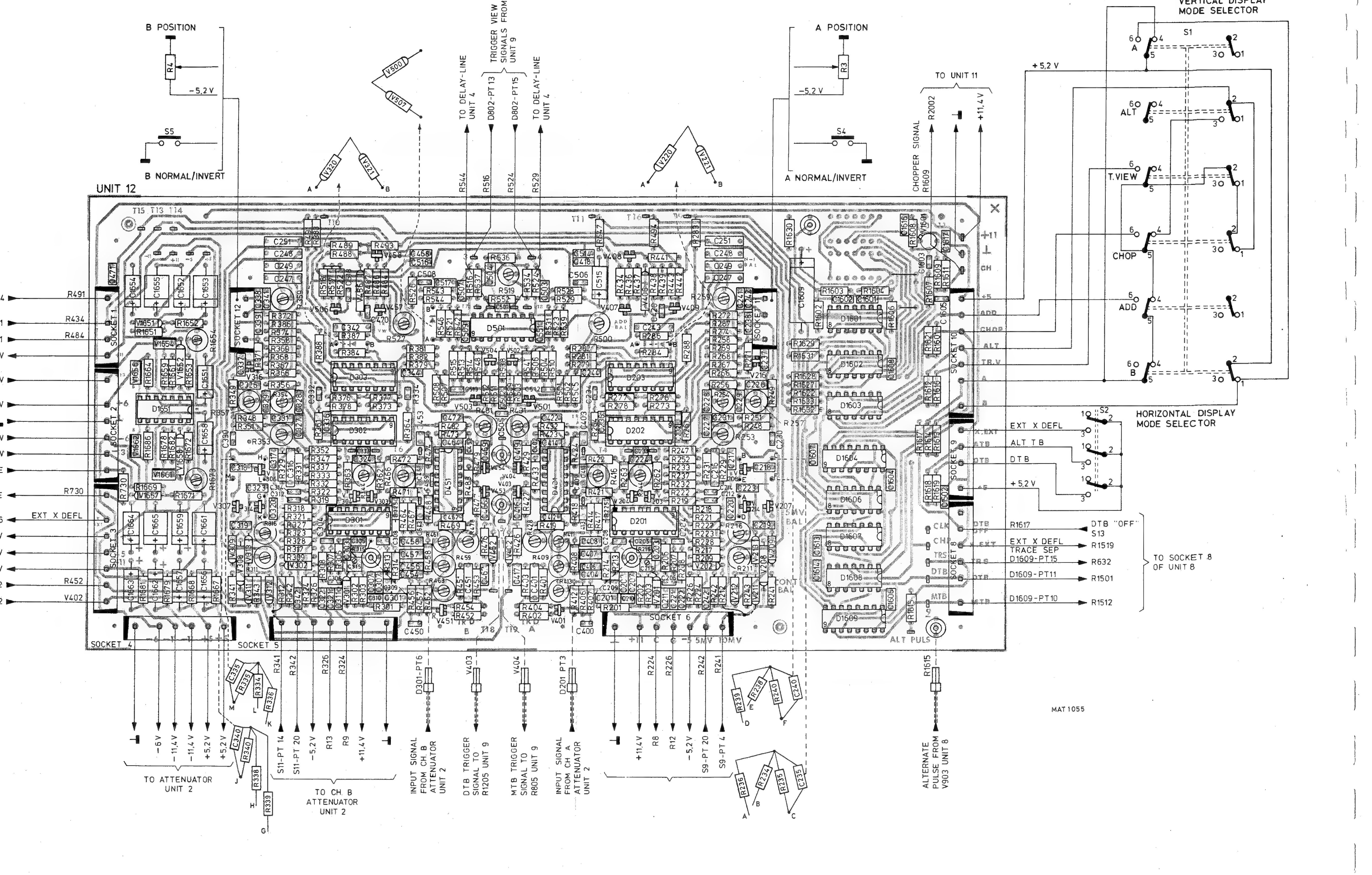


Fig. 12.9. Intermediate amplifier (unit 12), lay-out

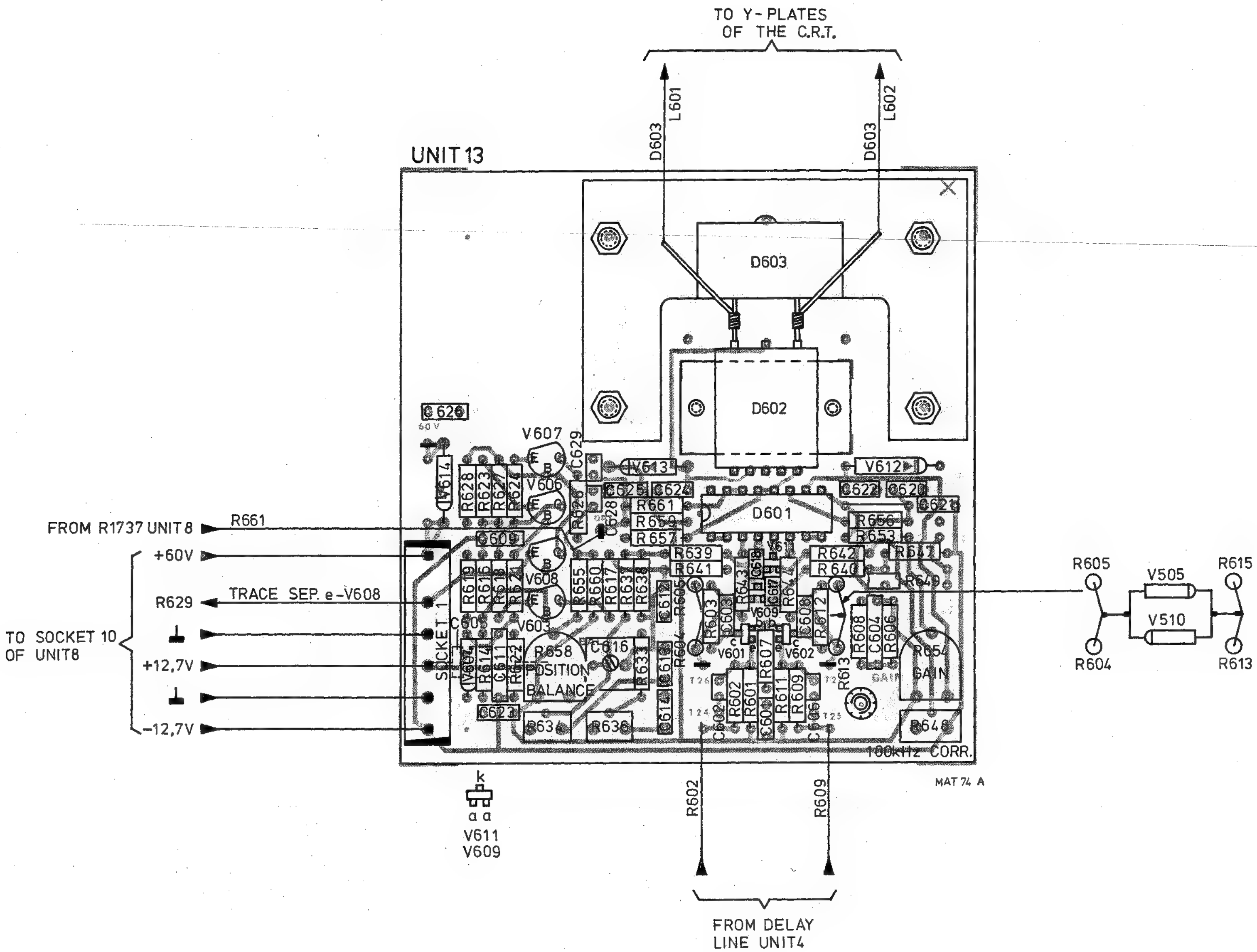


Fig. 12.10. Final Y-amplifier (unit 13), lay-out

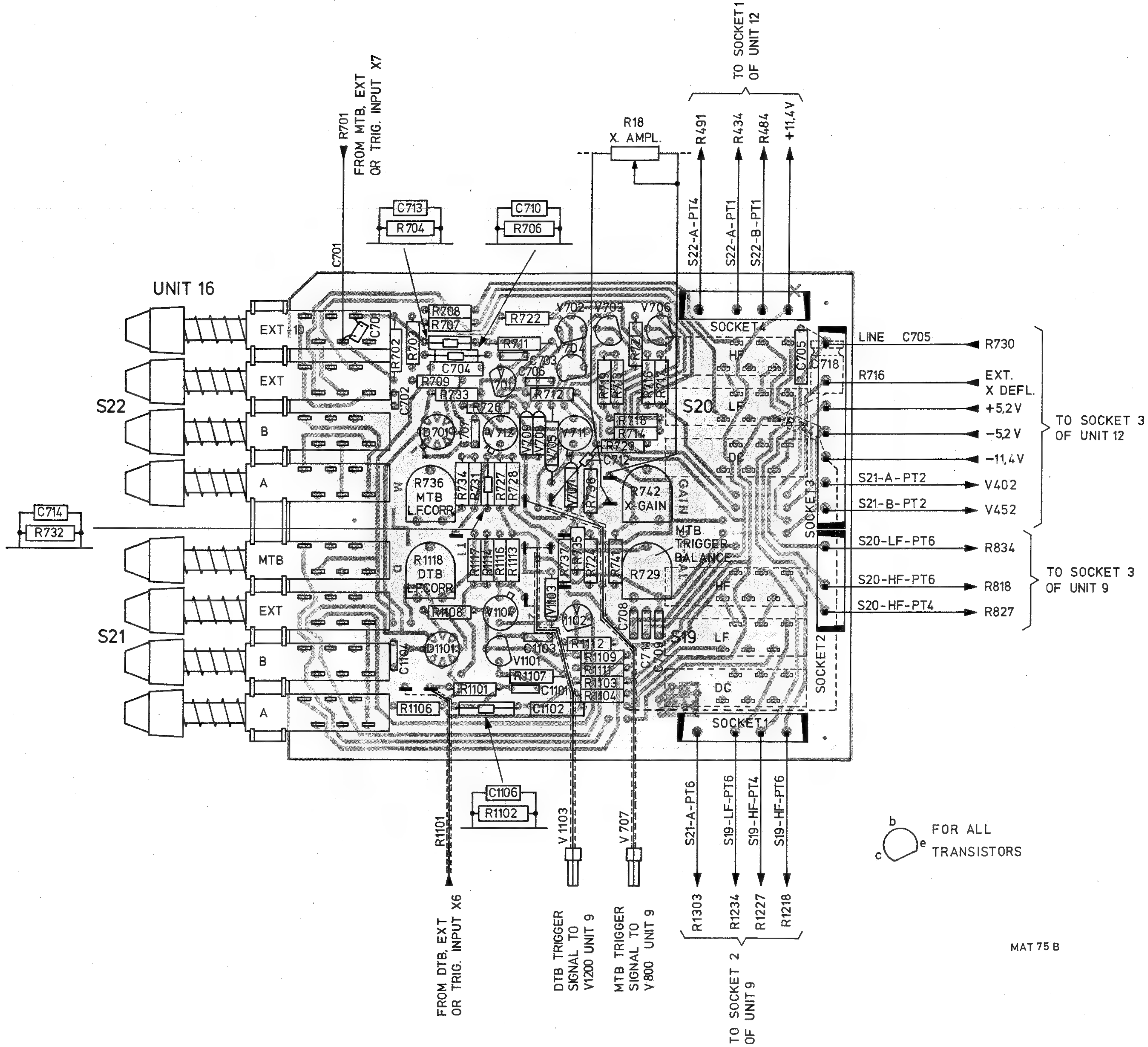


Fig. 12.11. Trigger source unit (unit 16), lay-out

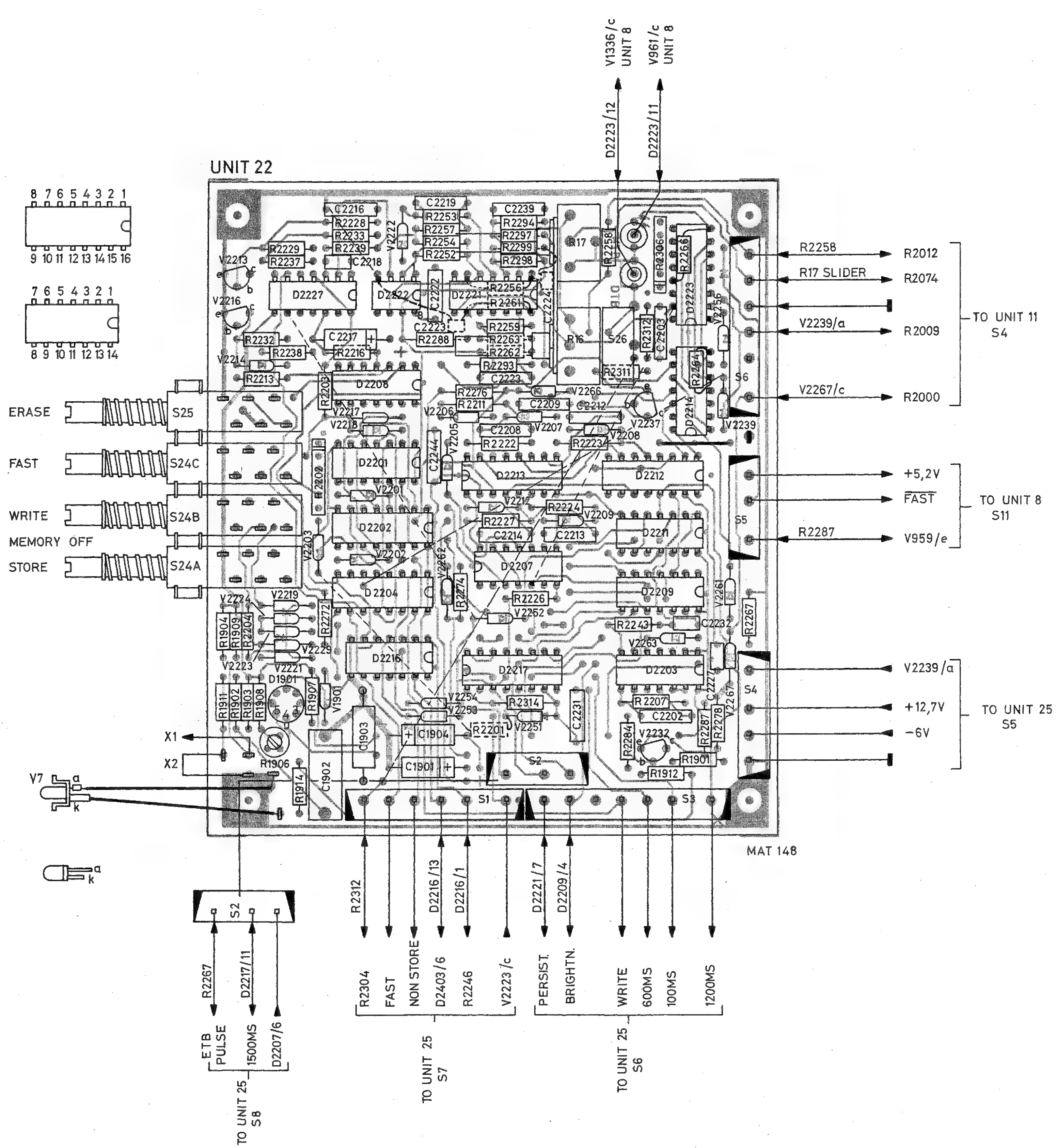


Fig. 12.12. Storage logic (unit 22), lay-out

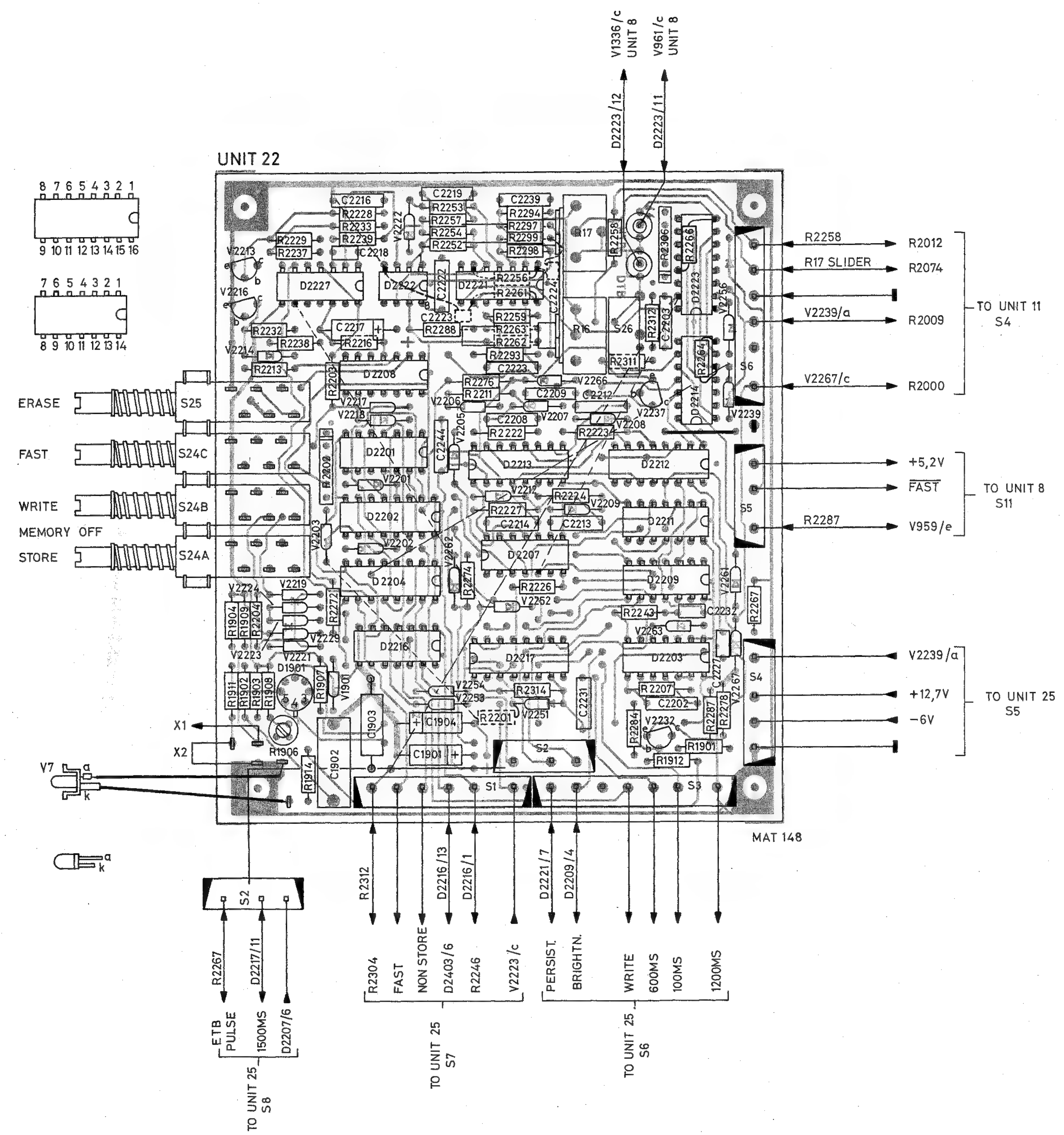


Fig. 12.12. Storage logic (unit 22), lay-out

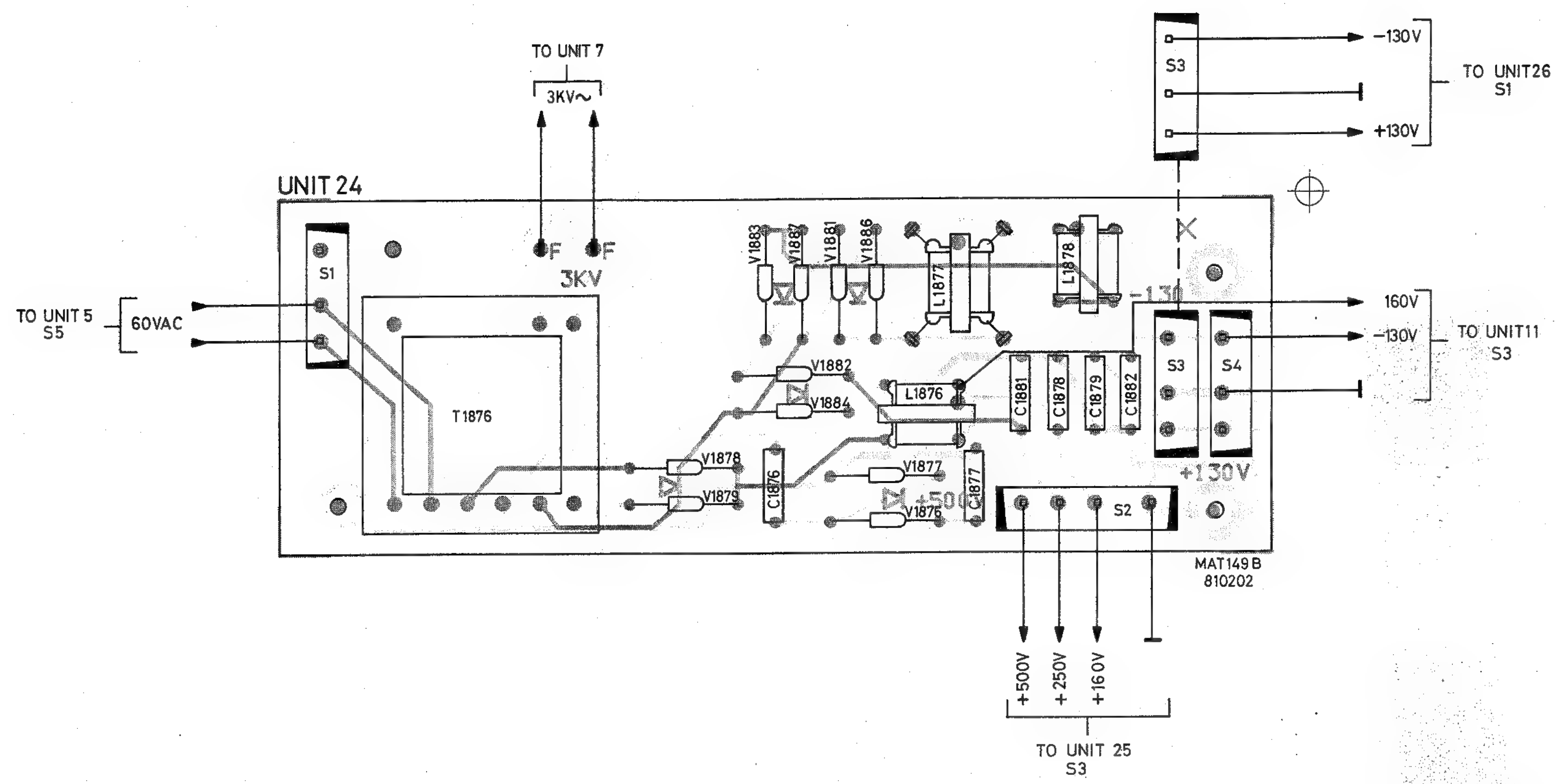


Fig. 12.13. Additional power supply (unit 24), lay-out

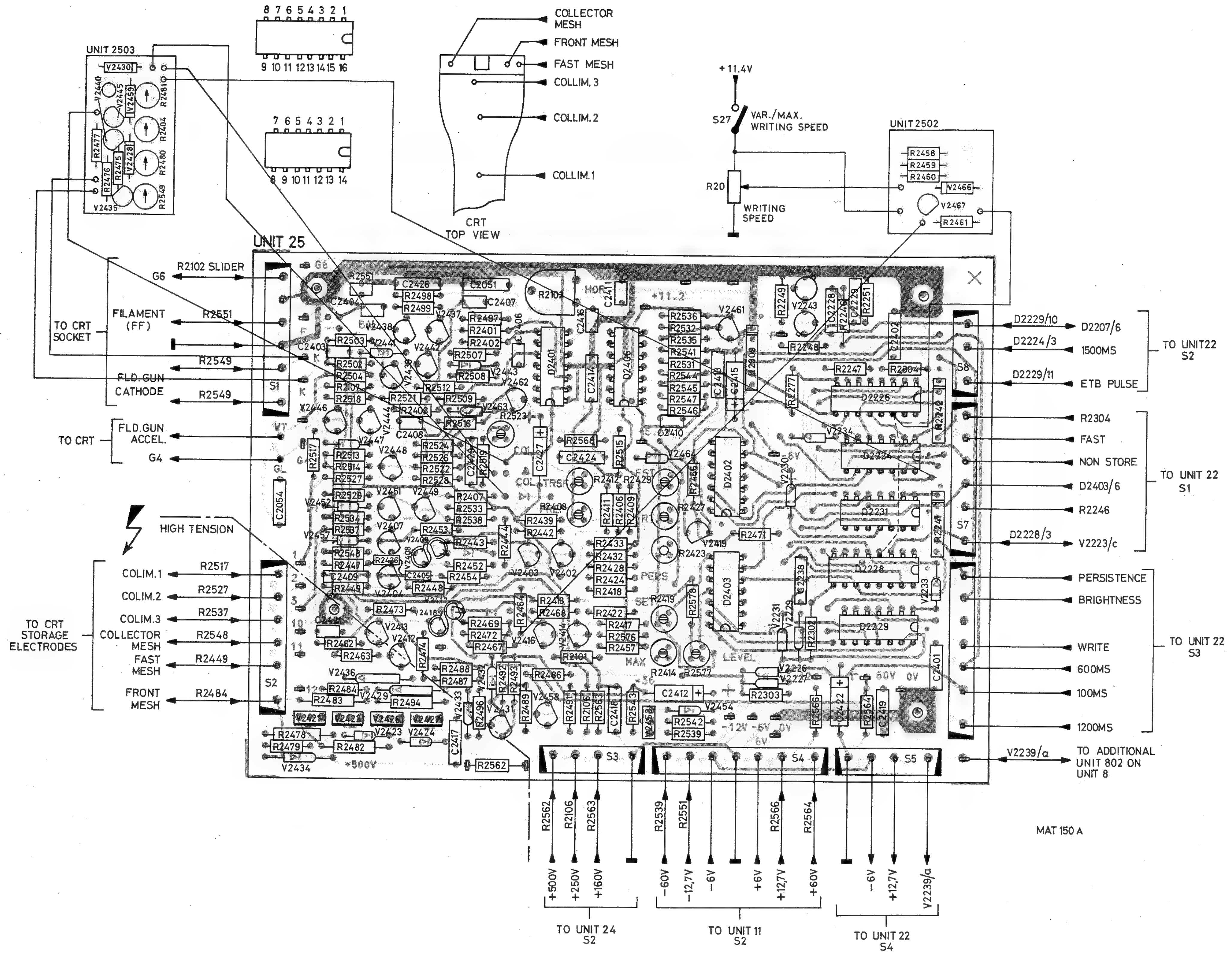


Fig. 12.14. Storage amplifier (unit 25), lay-out

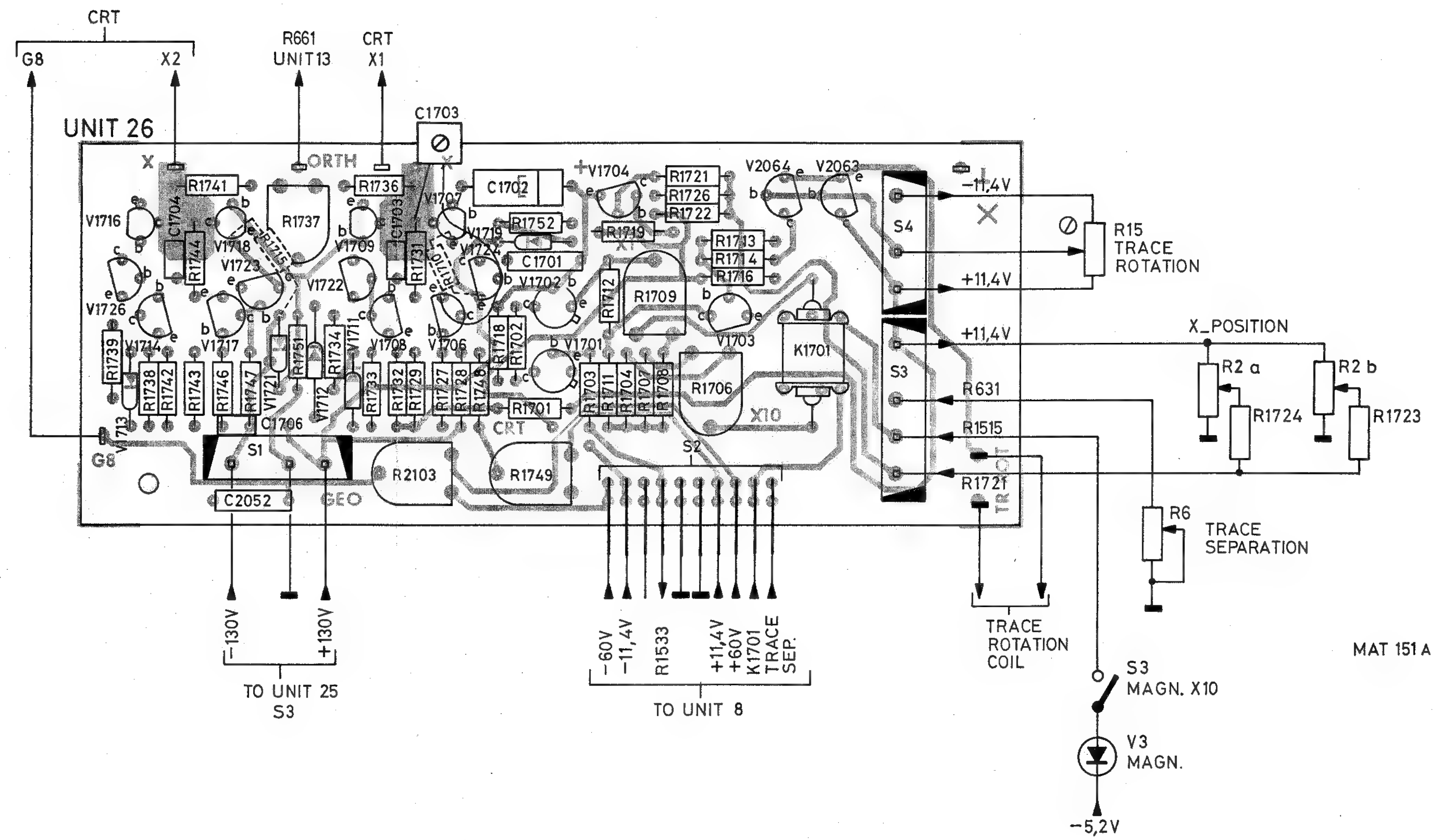
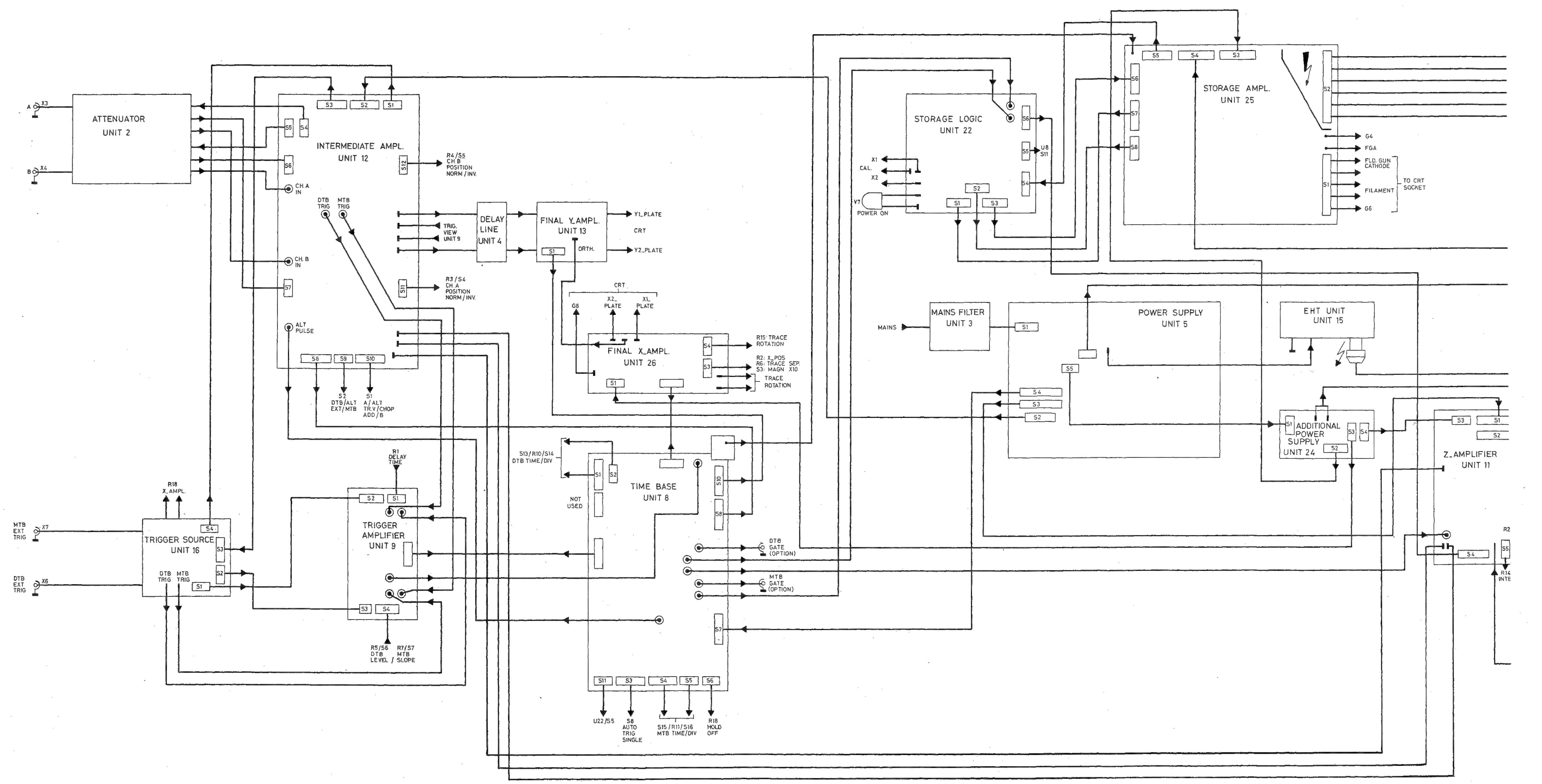


Fig. 12.15. Final X-amplifier (unit 26), lay-out



ATTENUATOR
UNIT 2
INTERMEDIATE AMPL.
UNIT 12
DELAY LINE
UNIT 4
FINAL Y AMPL.
UNIT 13
FINAL X AMPL.
UNIT 26
TRIGGER SOURCE
UNIT 16
TRIGGER AMPLIFIER
UNIT 9
TIME BASE
UNIT 8
STORAGE LOGIC
UNIT 22
STORAGE AMPL.
UNIT 25
MAINS FILTER
UNIT 3
POWER SUPPLY
UNIT 5
EHT UNIT
UNIT 15
ADDITIONAL POWER SUPPLY
UNIT 24
Z AMPLIFIER
UNIT 11
Y1 PLATE
Y2 PLATE
CRT
ORTH.
X2 PLATE
X1 PLATE
G6
MAINS
POWER ON
CAL.
G4
FGA
FLD. GUN CATHODE
FILAMENT
TO CRT SOCKET
DTB GATE (OPTION)
MTB GATE (OPTION)
NOT USED

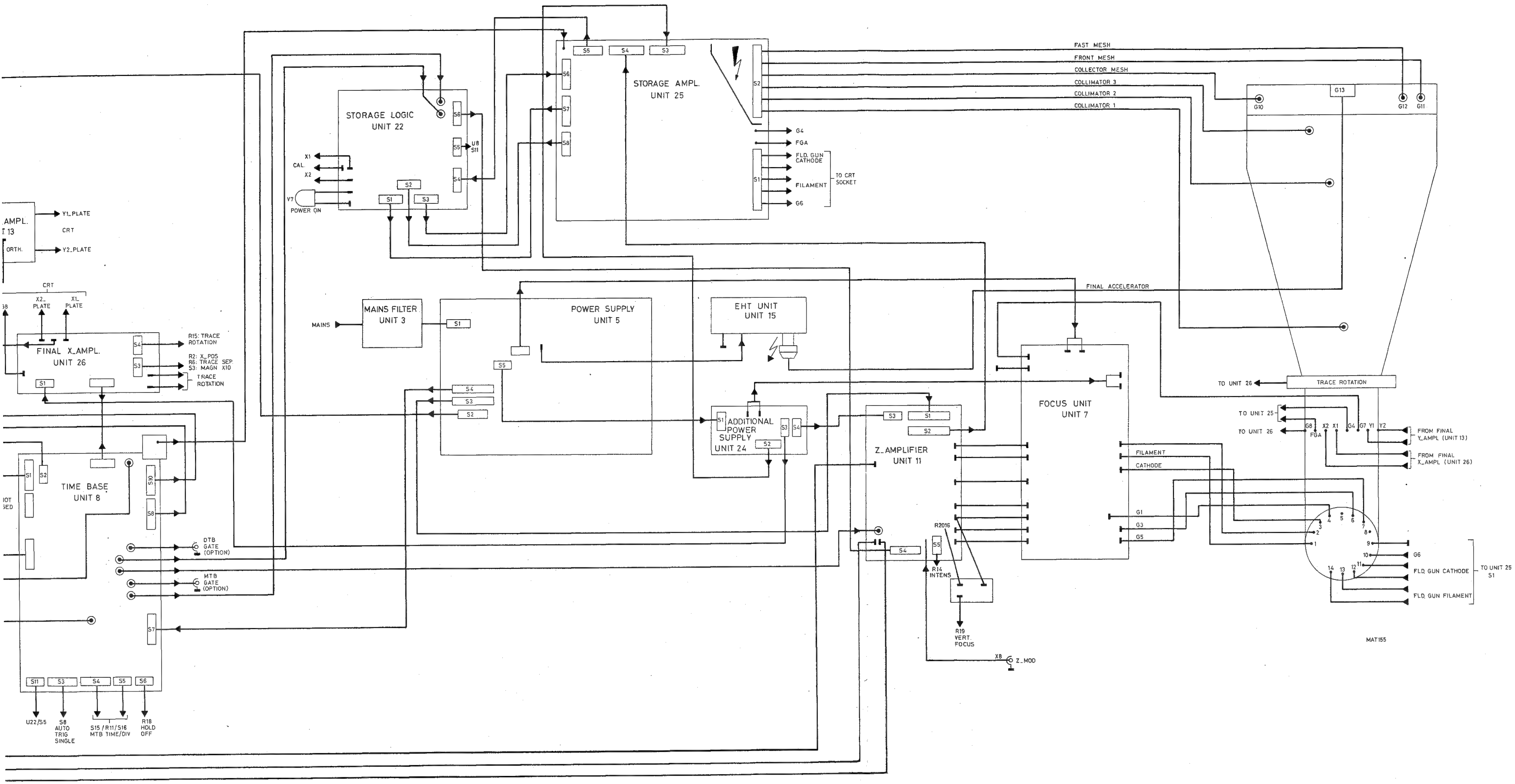
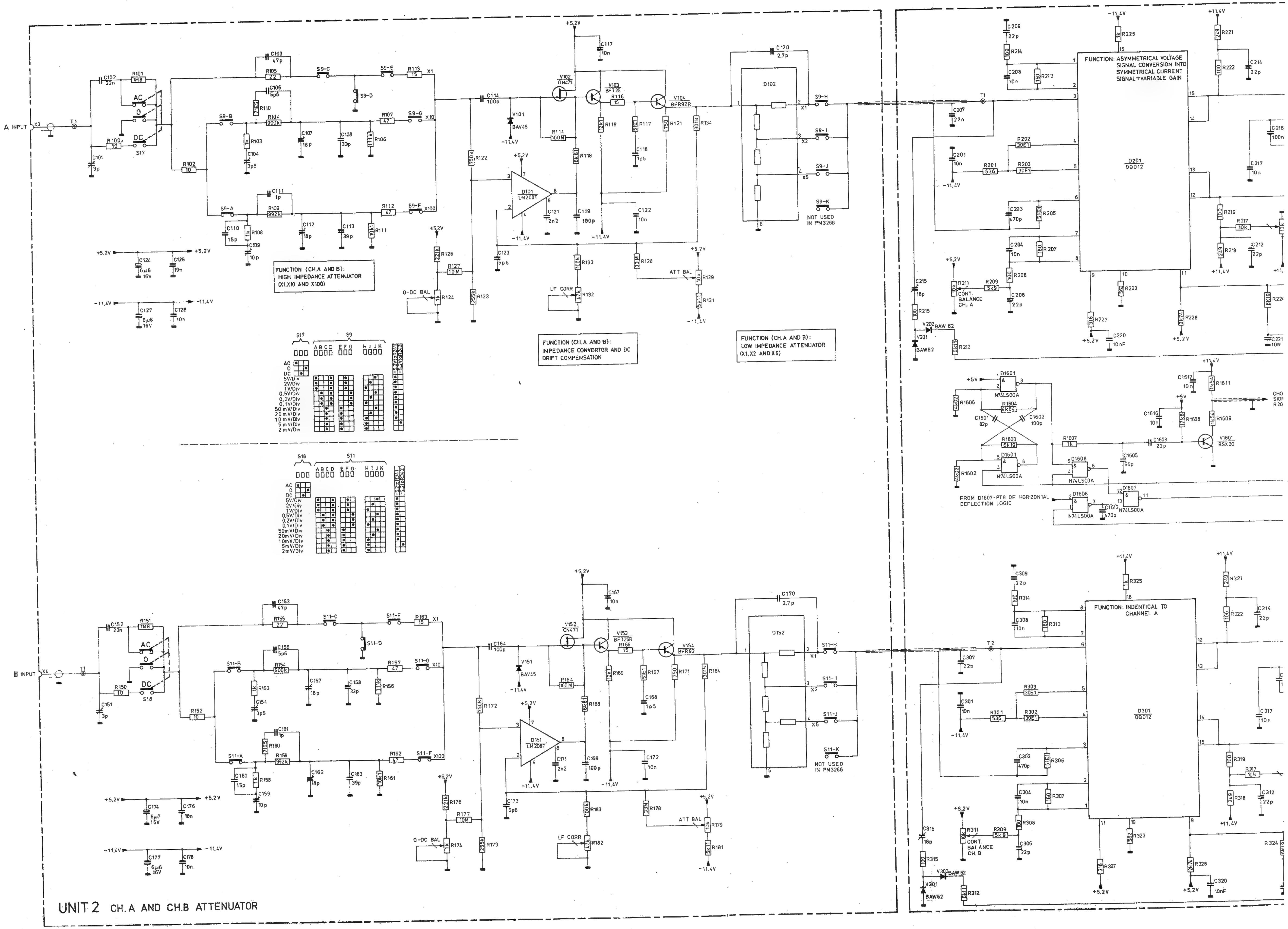
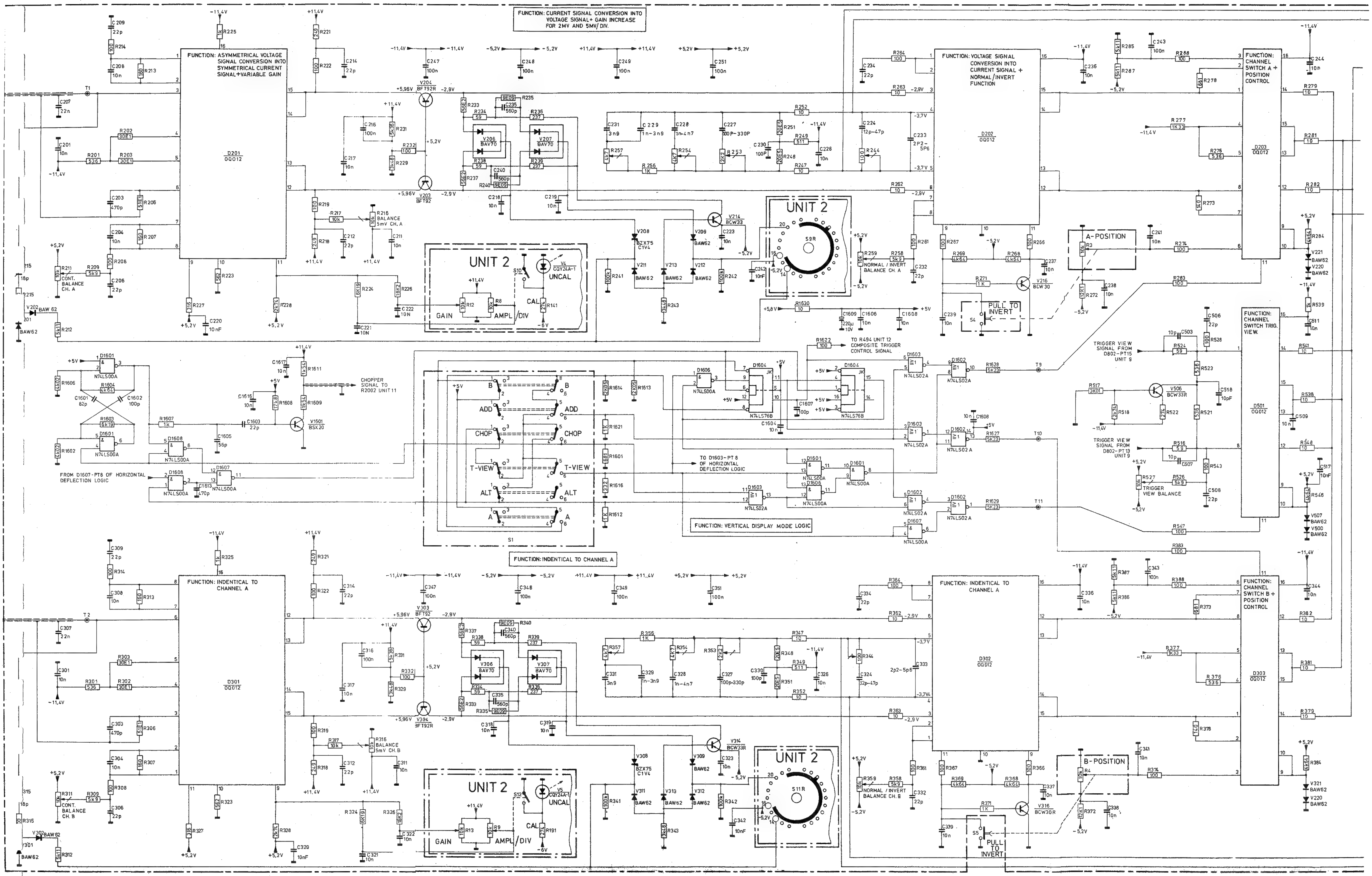


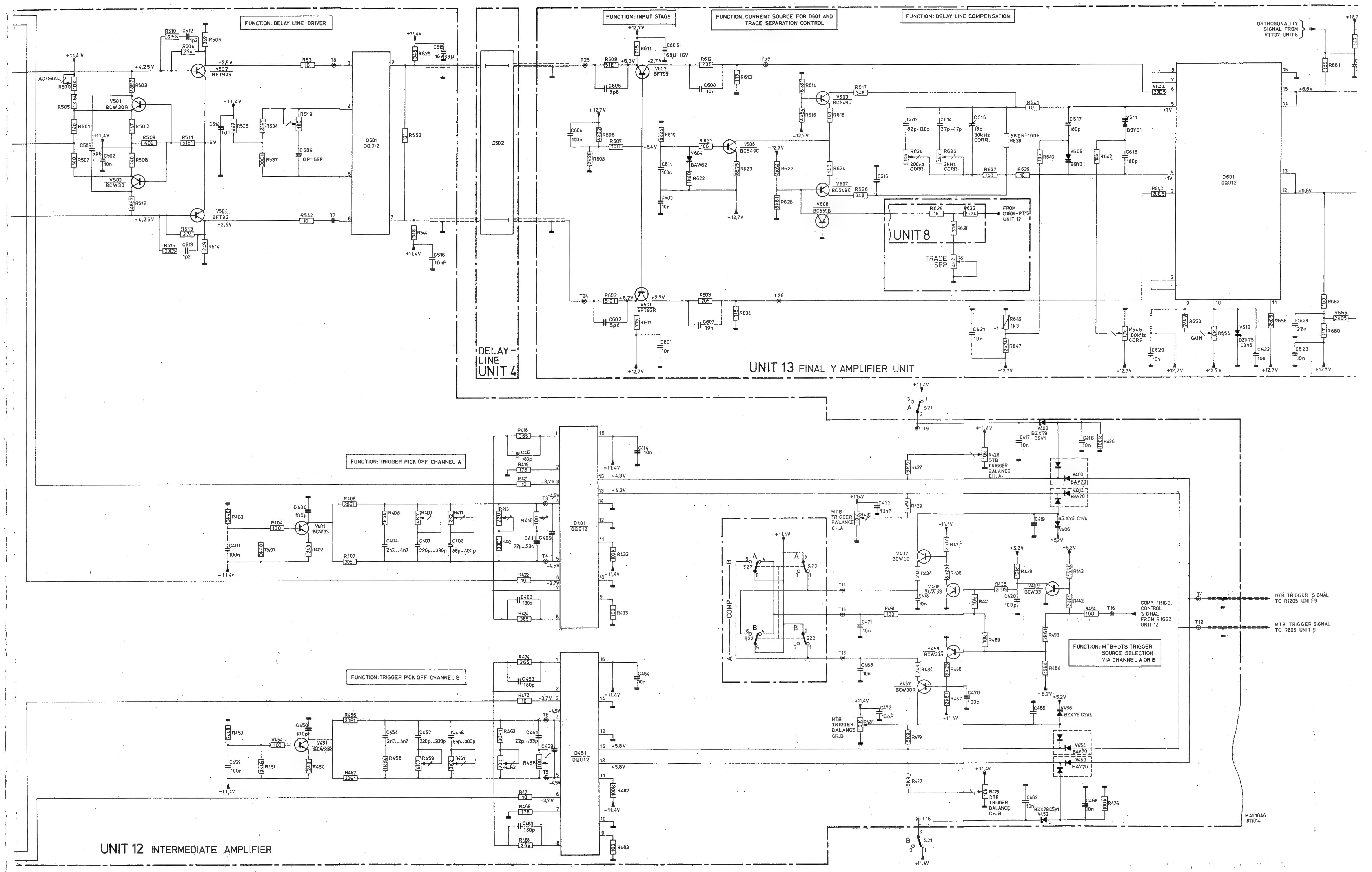
Fig. 12.16. Wiring diagram



UNIT 2 CH.A AND CH.B ATTENUATOR



FUNCTION: CURRENT SIGNAL CONVERSION INTO VOLTAGE SIGNAL+ GAIN INCREASE FOR 2MV AND 5MV/ DIV.
FUNCTION: ASYMMETRICAL VOLTAGE SIGNAL CONVERSION INTO SYMMETRICAL CURRENT SIGNAL+VARIABLE GAIN
D201 OQ012
FUNCTION: VOLTAGE SIGNAL CONVERSION INTO CURRENT SIGNAL + NORMAL/INVERT FUNCTION
D202 OQ012
FUNCTION: CHANNEL SWITCH A + POSITION CONTROL
D203 OQ012
UNIT 2
BALANCE 5mV CH. A
CONT. BALANCE CH. A
GAIN
AMPL/DIV
CAL
UNCAL
NORMAL / INVERT BALANCE CH. A
A-POSITION
PULL TO INVERT
CHOPPER SIGNAL TO R2002 UNIT 11
FROM D1607-PT8 OF HORIZONTAL DEFLECTION LOGIC
TO R494 UNIT 12 COMPOSITE TRIGGER CONTROL SIGNAL
TO D1603-PT 8 OF HORIZONTAL DEFLECTION LOGIC
FUNCTION: VERTICAL DISPLAY MODE LOGIC
B
ADD
CHOP
T-VIEW
ALT
A
S1
FUNCTION: CHANNEL SWITCH TRIG. VIEW.
D501 OQ012
TRIGGER VIEW SIGNAL FROM D802-PT15 UNIT 9
TRIGGER VIEW SIGNAL FROM D802-PT13 UNIT 9
TRIGGER VIEW BALANCE
FUNCTION: INDENTICAL TO CHANNEL A
FUNCTION: INDENTICAL TO CHANNEL A
D301 OQ012
FUNCTION: INDENTICAL TO CHANNEL A
D302 OQ012
FUNCTION: CHANNEL SWITCH B + POSITION CONTROL
D303 OQ012
BALANCE 5mV CH. B
CONT. BALANCE CH. B
NORMAL / INVERT BALANCE CH. B
B-POSITION
PULL TO INVERT



FUNCTION: DELAY LINE DRIVER
FUNCTION: INPUT STAGE
FUNCTION: CURRENT SOURCE FOR D601 AND TRACE SEPARATION CONTROL
FUNCTION: DELAY LINE COMPENSATION
ORTHOGONALITY SIGNAL FROM R1737 UNIT 8
DELAY LINE UNIT 4
UNIT 8
TRACE SEP.
FROM D1609-PT15 UNIT 12
UNIT 13 FINAL Y AMPLIFIER UNIT
FUNCTION: TRIGGER PICK OFF CHANNEL A
FUNCTION: TRIGGER PICK OFF CHANNEL B
MTB TRIGGER BALANCE CH.A
MTB TRIGGER BALANCE CH.B
DTB TRIGGER BALANCE CH. A
DTB TRIGGER BALANCE CH. B
COMP. TRIGG. CONTROL SIGNAL FROM R1622 UNIT 12
FUNCTION: MTB+DTB TRIGGER SOURCE SELECTION VIA CHANNEL A OR B
DTB TRIGGER SIGNAL TO R1205 UNIT 9
MTB TRIGGER SIGNAL TO R805 UNIT 9
UNIT 12 INTERMEDIATE AMPLIFIER
MAT 1046 811014

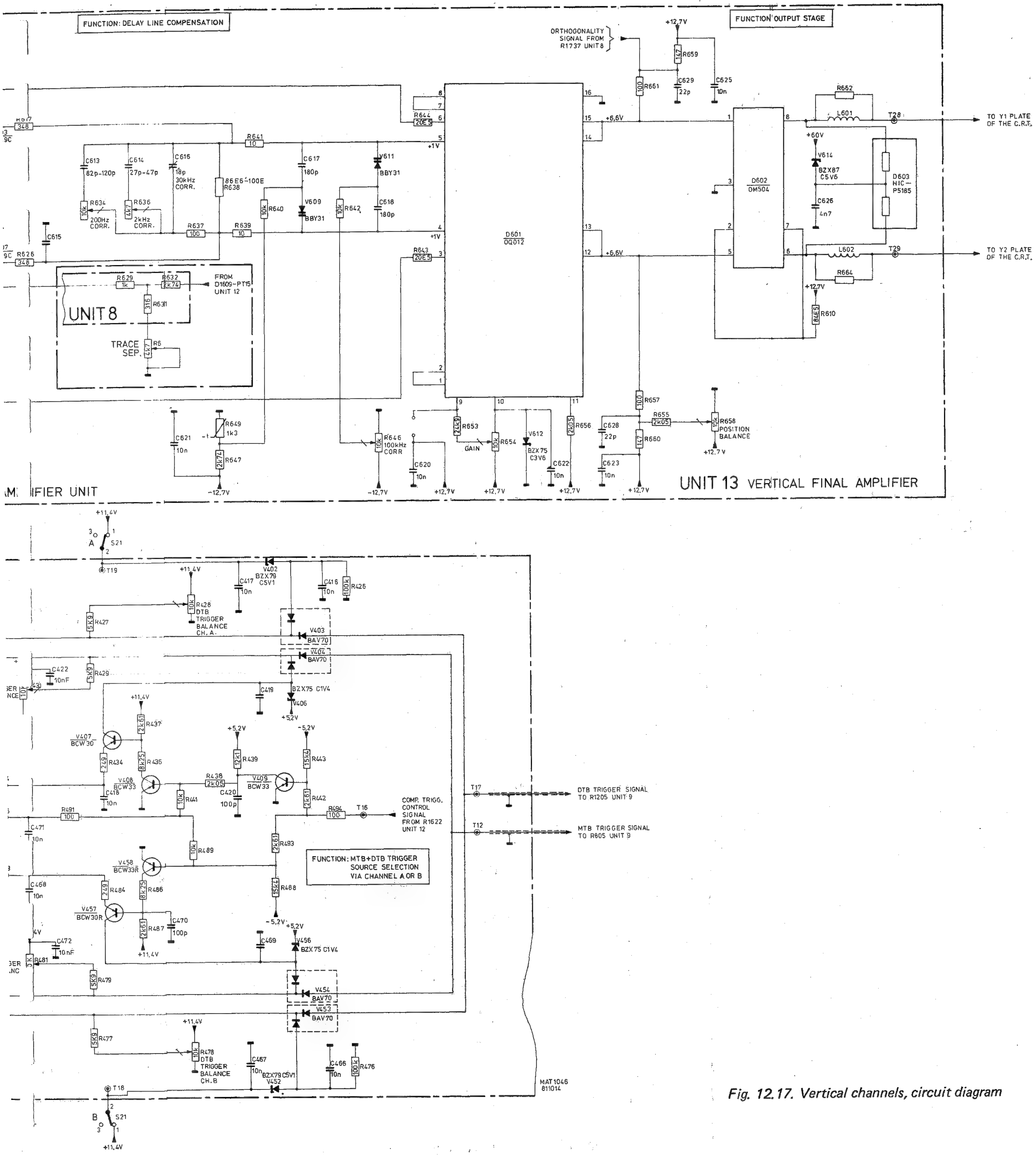
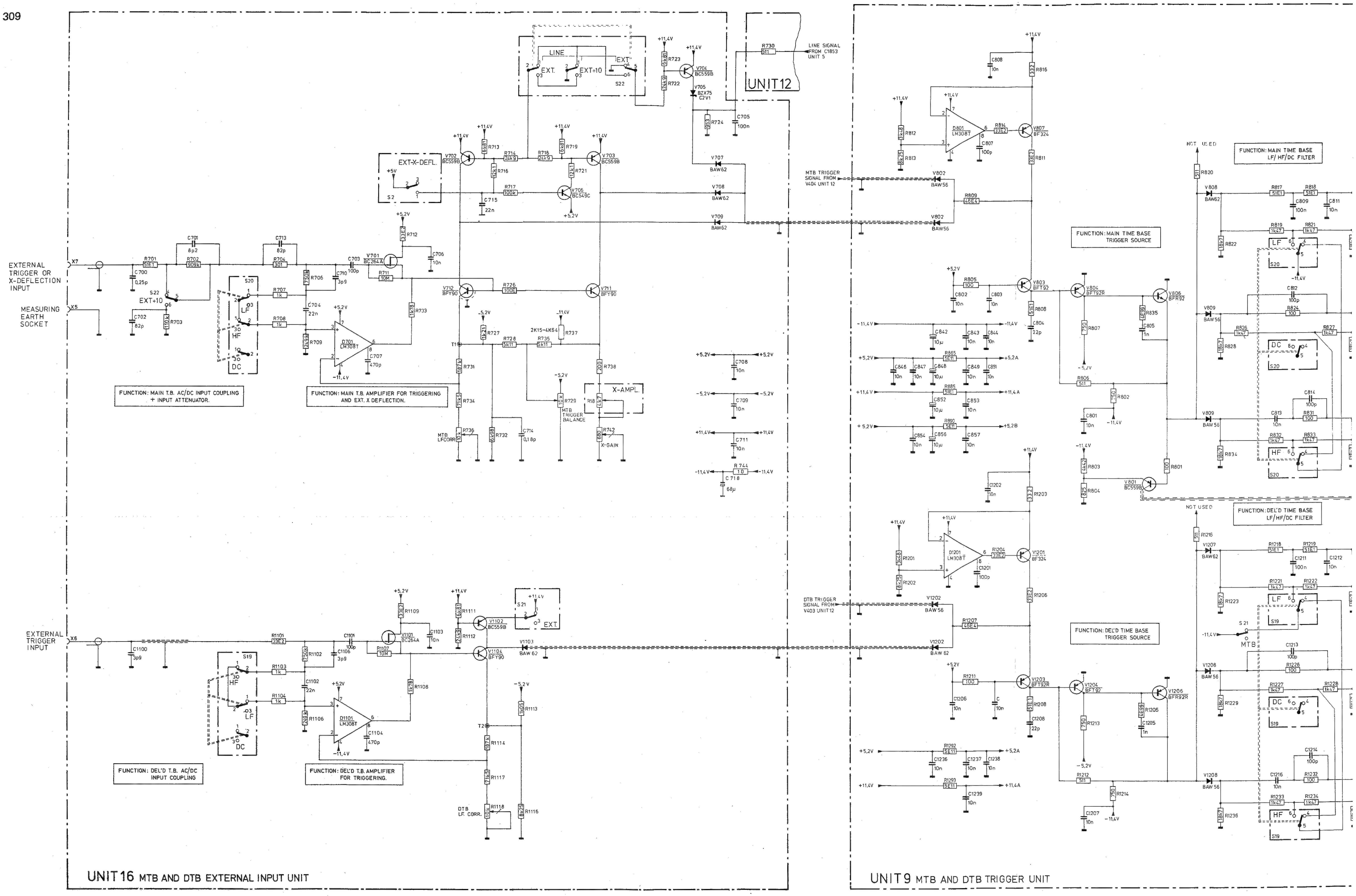
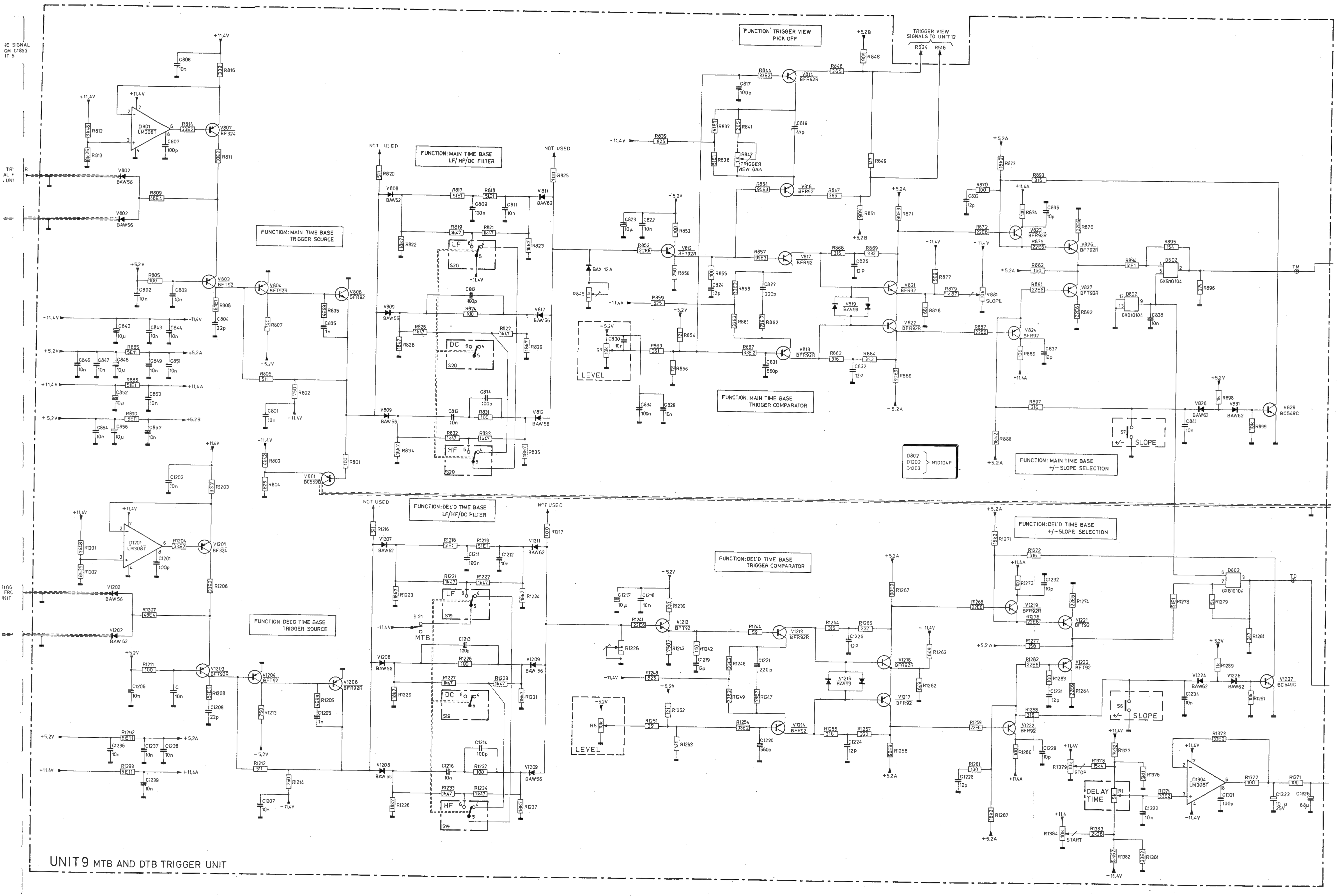
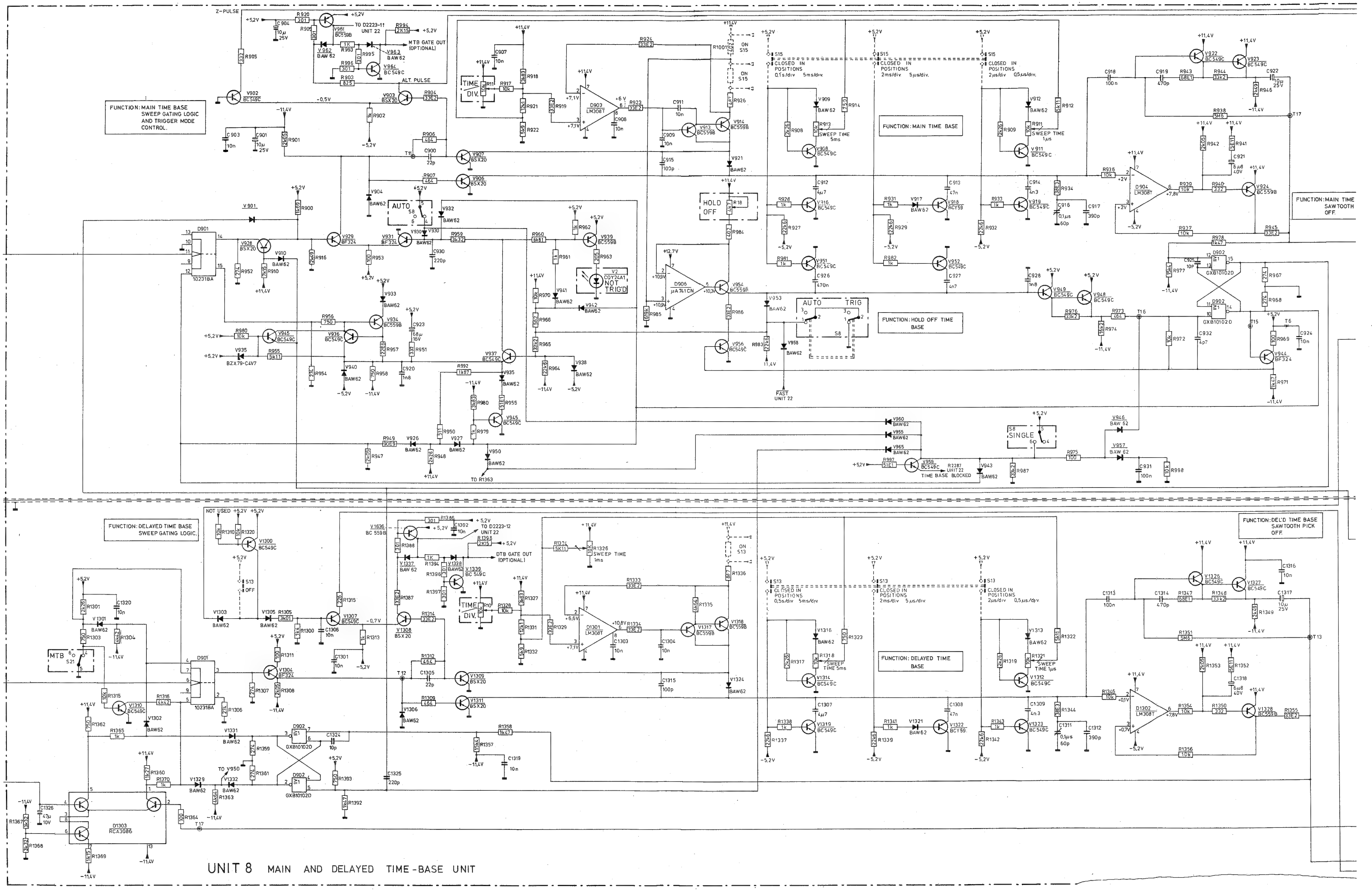


Fig. 12.17. Vertical channels, circuit diagram

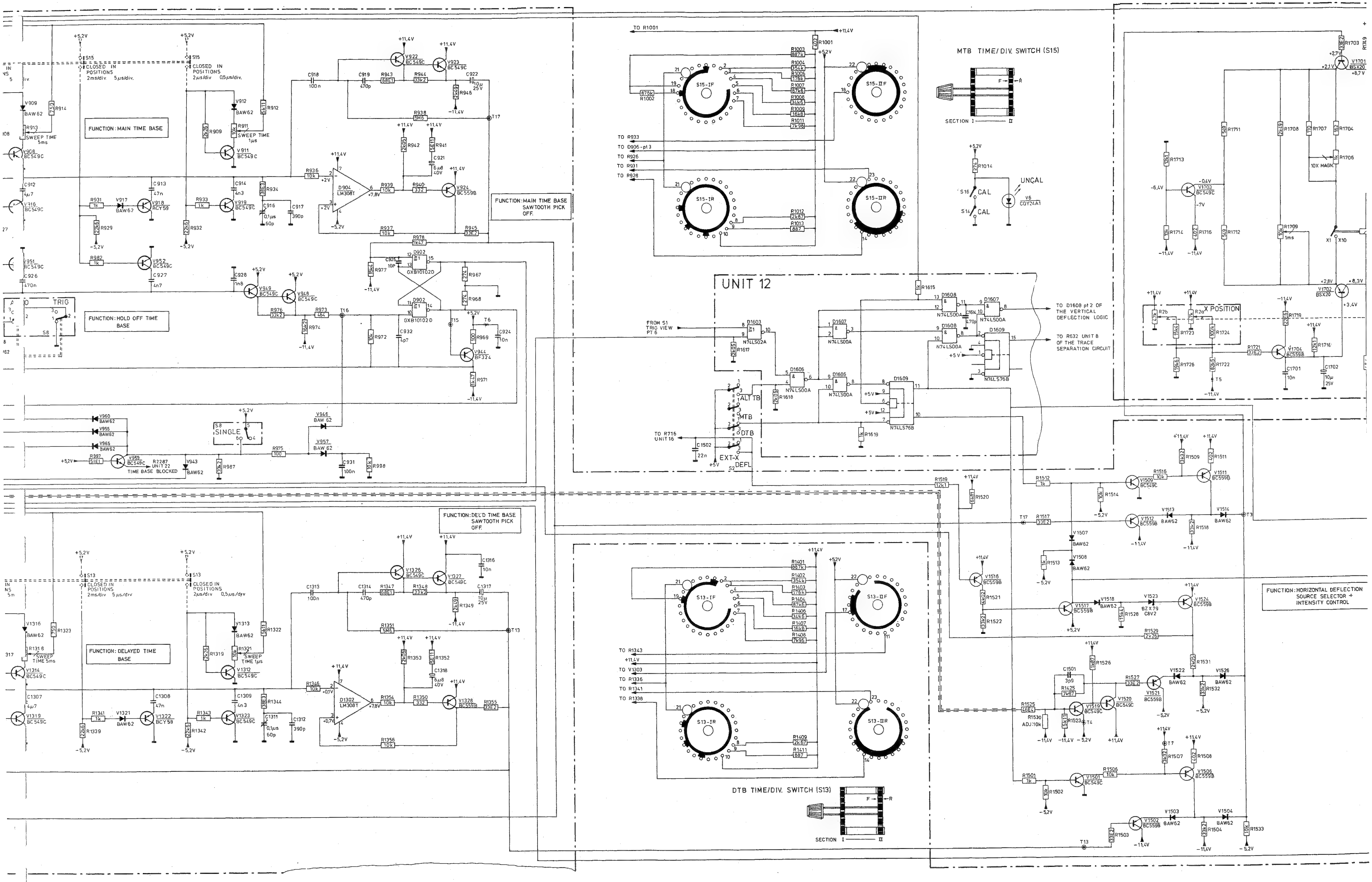

EXTERNAL TRIGGER OR X-DEFLECTION INPUT
MEASURING EARTH SOCKET
EXTERNAL TRIGGER INPUT
EXT-X-DEFL.
LINE
EXT.
EXT÷10
UNIT12
LINE SIGNAL FROM C1853 UNIT 5
FUNCTION: MAIN T.B. AC/DC INPUT COUPLING + INPUT ATTENUATOR.
FUNCTION: MAIN T.B. AMPLIFIER FOR TRIGGERING AND EXT. X DEFLECTION.
MTB TRIGGER BALANCE
X-AMPL.
X-GAIN
MTB LF.CORR.
FUNCTION: DEL'D T.B. AC/DC INPUT COUPLING
FUNCTION: DEL'D T.B. AMPLIFIER FOR TRIGGERING.
DTB LF. CORR.
UNIT16 MTB AND DTB EXTERNAL INPUT UNIT
MTB TRIGGER SIGNAL FROM V404 UNIT 12
DTB TRIGGER SIGNAL FROM V403 UNIT 12
FUNCTION: MAIN TIME BASE TRIGGER SOURCE
FUNCTION: MAIN TIME BASE LF/HF/DC FILTER
FUNCTION: DEL'D TIME BASE TRIGGER SOURCE
FUNCTION: DEL'D TIME BASE LF/HF/DC FILTER
NOT USED
UNIT9 MTB AND DTB TRIGGER UNIT



UNIT 9 MTB AND DTB TRIGGER UNIT



UNIT 8 MAIN AND DELAYED TIME-BASE UNIT


FUNCTION: MAIN TIME BASE
FUNCTION: MAIN TIME BASE SAWTOOTH PICK OFF.
FUNCTION: HOLD OFF TIME BASE
FUNCTION: DEL'D TIME BASE SAWTOOTH PICK OFF.
FUNCTION: DELAYED TIME BASE
MTB TIME/DIV. SWITCH (S15)
DTB TIME/DIV. SWITCH (S13)
SECTION I — II
UNIT 12
UNCAL
CAL
SINGLE
TRIG
ALT TB
MTB
DTB
EXT-X DEFL
X POSITION
10X MAGN.
TIME BASE BLOCKED
FROM S1 TRIG VIEW PT 6
TO R716 UNIT 16
TO D1608 pt 2 OF THE VERTICAL DEFLECTION LOGIC
TO R632 UNIT 8 OF THE TRACE SEPARATION CIRCUIT
FUNCTION: HORIZONTAL DEFLECTION SOURCE SELECTOR + INTENSITY CONTROL
CLOSED IN POSITIONS 2ms/div 5µs/div.
CLOSED IN POSITIONS 2ms/div 0,5µs/div.

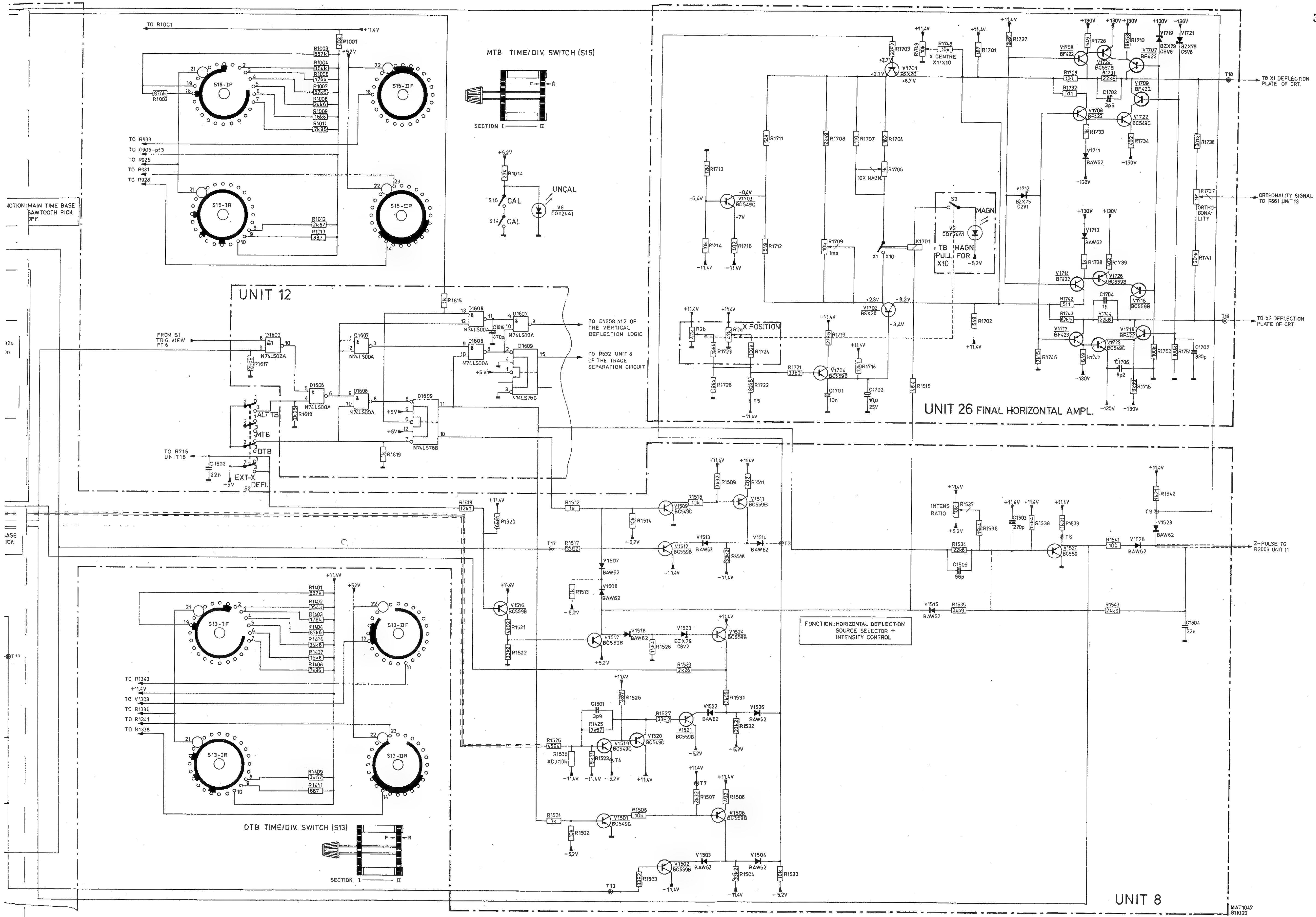
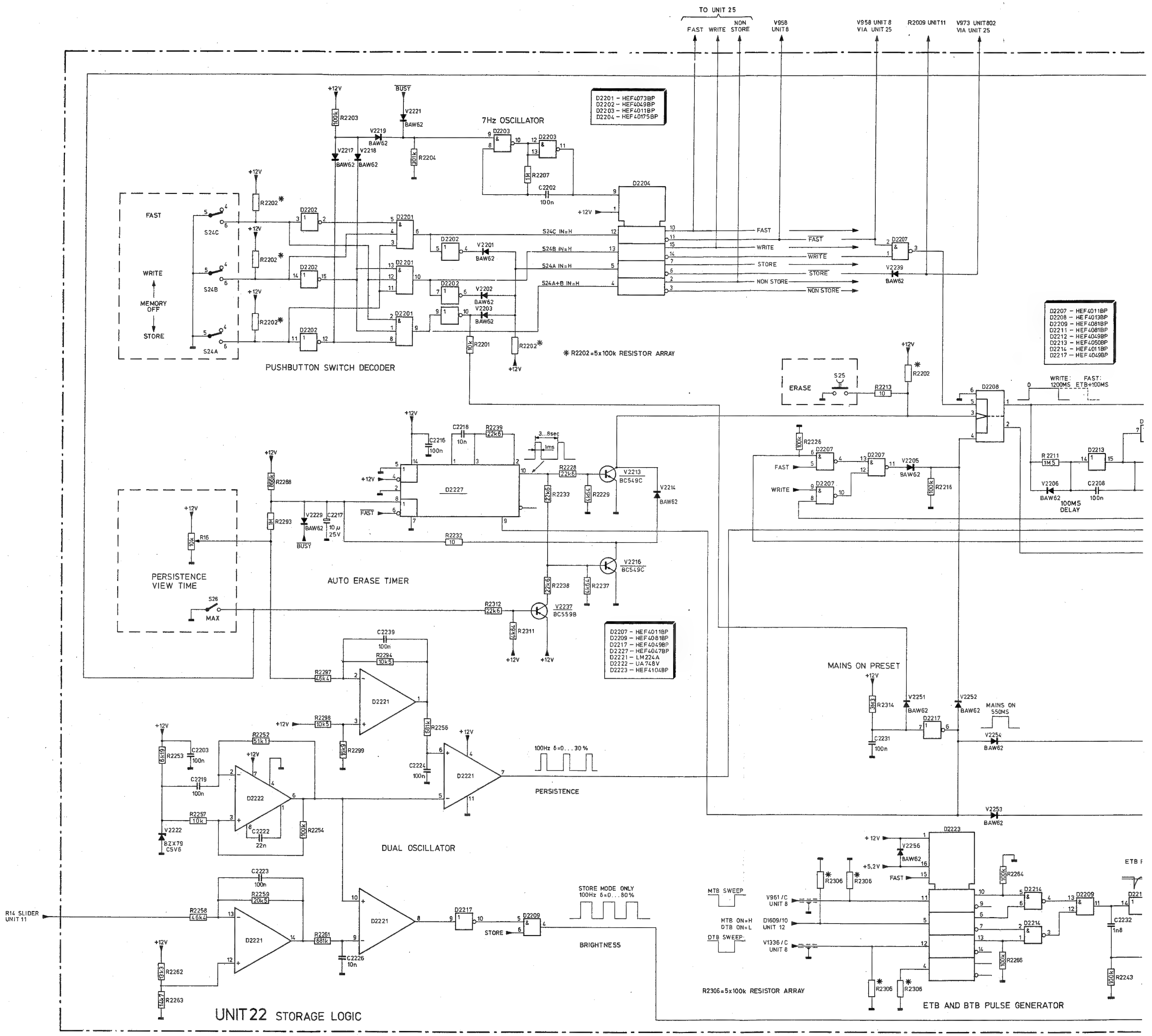
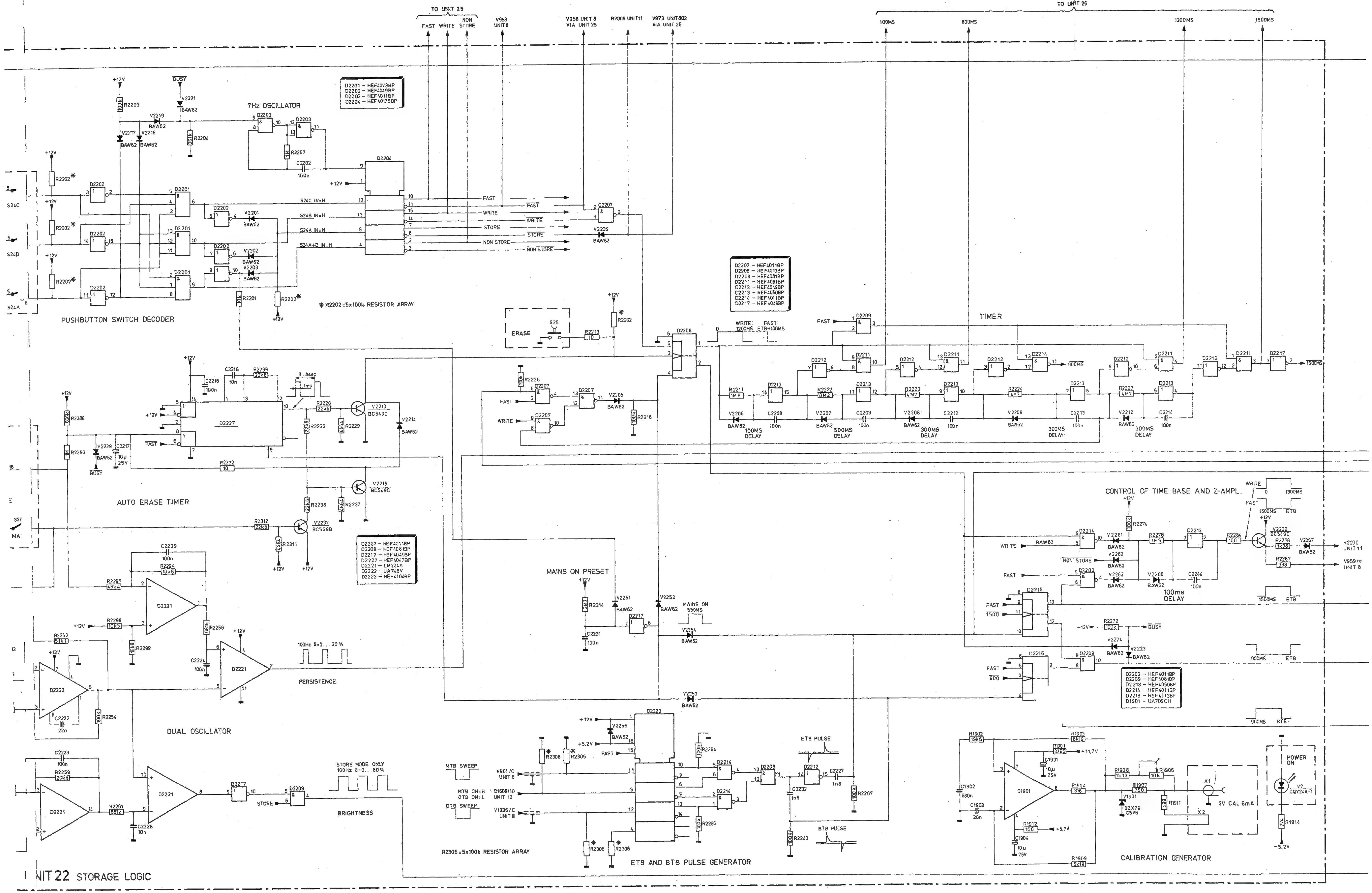
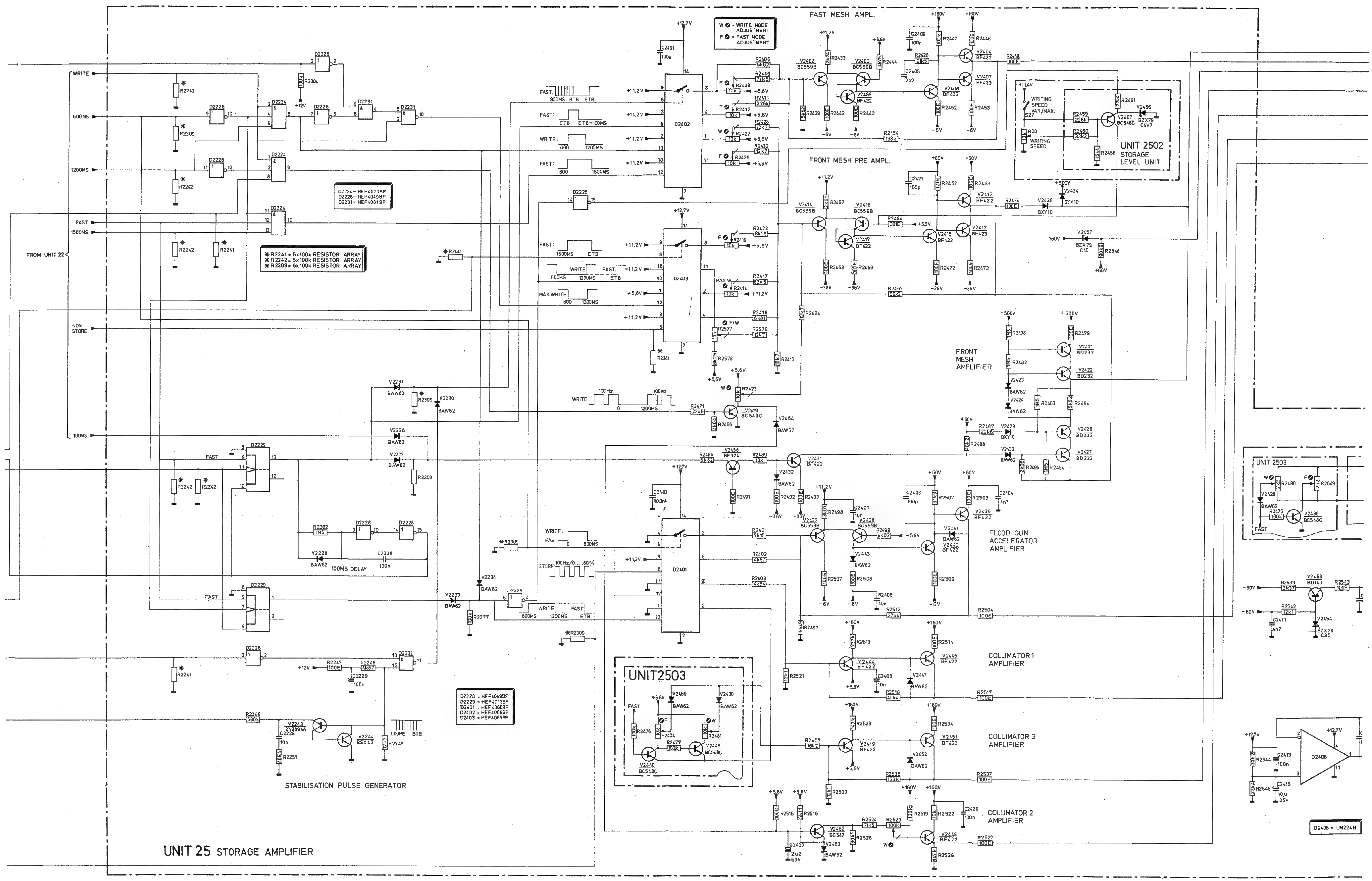


Fig. 12.18. Horizontal deflection, circuit diagram


TO UNIT 25
FAST WRITE STORE
NON STORE
V958 UNIT 8
V958 UNIT 8 VIA UNIT 25
R2009 UNIT11
V973 UNIT802 VIA UNIT 25
7Hz OSCILLATOR
D2201 - HEF4073BP
D2202 - HEF4049BP
D2203 - HEF4011BP
D2204 - HEF40175BP
FAST
WRITE
MEMORY OFF
STORE
PUSHBUTTON SWITCH DECODER
✱ R2202 = 5x100k RESISTOR ARRAY
D2207 - HEF4011BP
D2208 - HEF4013BP
D2209 - HEF4081BP
D2211 - HEF4081BP
D2212 - HEF4049BP
D2213 - HEF4050BP
D2214 - HEF4011BP
D2217 - HEF4049BP
ERASE
WRITE: 1200MS
FAST: ETB+100MS
100MS DELAY
PERSISTENCE VIEW TIME
AUTO ERASE TIMER
D2207 - HEF4011BP
D2209 - HEF4081BP
D2217 - HEF4049BP
D2227 - HEF4047BP
D2221 - LM224A
D2222 - UA748V
D2223 - HEF4104BP
MAINS ON PRESET
MAINS ON 550MS
100Hz δ=0...30%
PERSISTENCE
DUAL OSCILLATOR
STORE MODE ONLY 100Hz δ=0...80%
BRIGHTNESS
R14 SLIDER UNIT 11
MTB SWEEP
MTB ON=H DTB ON=L
DTB SWEEP
V951/C UNIT 8
D1609/10 UNIT 12
V1336/C UNIT 8
R2306 = 5x100k RESISTOR ARRAY
ETB AND BTB PULSE GENERATOR
UNIT 22 STORAGE LOGIC


TO UNIT 25
FAST WRITE NON STORE
V958 UNIT 8
V958 UNIT 8 VIA UNIT 25
R2009 UNIT 11
V973 UNIT 802 VIA UNIT 25
TO UNIT 25
100MS
500MS
1200MS
1500MS
D2201 – HEF4073BP
D2202 – HEF4049BP
D2203 – HEF4011BP
D2204 – HEF40175BP
7Hz OSCILLATOR
PUSHBUTTON SWITCH DECODER
✱ R2202 = 5x100k RESISTOR ARRAY
S24C IN=H
S24B IN=H
S24A IN=H
S24A+B IN=H
FAST
WRITE
STORE
NON STORE
ERASE
D2207 – HEF4011BP
D2208 – HEF4013BP
D2209 – HEF4081BP
D2211 – HEF4081BP
D2212 – HEF4049BP
D2213 – HEF4050BP
D2214 – HEF4011BP
D2217 – HEF4049BP
WRITE: 1200MS
FAST: ETB+100MS
TIMER
100MS DELAY
500MS DELAY
300MS DELAY
300MS DELAY
300MS DELAY
AUTO ERASE TIMER
3...8sec
1ms
D2207 – HEF4011BP
D2209 – HEF4081BP
D2217 – HEF4049BP
D2227 – HEF4047BP
D2221 – LM224A
D2222 – UA748V
D2223 – HEF4104BP
MAINS ON PRESET
MAINS ON 550MS
CONTROL OF TIME BASE AND Z-AMPL.
100ms DELAY
R2000 UNIT 11
V959/# UNIT 8
D2203 – HEF4011BP
D2209 – HEF4081BP
D2213 – HEF4050BP
D2214 – HEF4011BP
D2216 – HEF4013BP
D1901 – UA709CH
DUAL OSCILLATOR
100Hz δ=0...30%
PERSISTENCE
STORE MODE ONLY 100Hz δ=0...80%
BRIGHTNESS
MTB SWEEP
MTB ON=H DTB ON=L
DTB SWEEP
V961/C UNIT 8
D1609/10 UNIT 12
V1336/C UNIT 8
R2306 = 5x100k RESISTOR ARRAY
ETB PULSE
BTB PULSE
ETB AND BTB PULSE GENERATOR
3V CAL 6mA
POWER ON
CALIBRATION GENERATOR
UNIT 22 STORAGE LOGIC


UNIT 25 STORAGE AMPLIFIER
FAST MESH AMPL.
FRONT MESH PRE AMPL.
FRONT MESH AMPLIFIER
FLOOD GUN ACCELERATOR AMPLIFIER
COLLIMATOR 1 AMPLIFIER
COLLIMATOR 3 AMPLIFIER
COLLIMATOR 2 AMPLIFIER
UNIT 2502 STORAGE LEVEL UNIT
UNIT 2503
STABILISATION PULSE GENERATOR
100MS DELAY
FROM UNIT 22
WRITE
600MS
1200MS
FAST
1500MS
NON STORE
100MS
W = WRITE MODE ADJUSTMENT
F = FAST MODE ADJUSTMENT
D2224 - HEF4073BP
D2226 - HEF4049BP
D2231 - HEF4081BP
R2241 = 5x100k RESISTOR ARRAY
R2242 = 5x100k RESISTOR ARRAY
R2309 = 5x100k RESISTOR ARRAY
D2228 = HEF4049BP
D2229 = HEF4013BP
D2401 = HEF4066BP
D2402 = HEF4066BP
D2403 = HEF4066BP
D2406 = LM224N
WRITING SPEED VAR./MAX.
WRITING SPEED

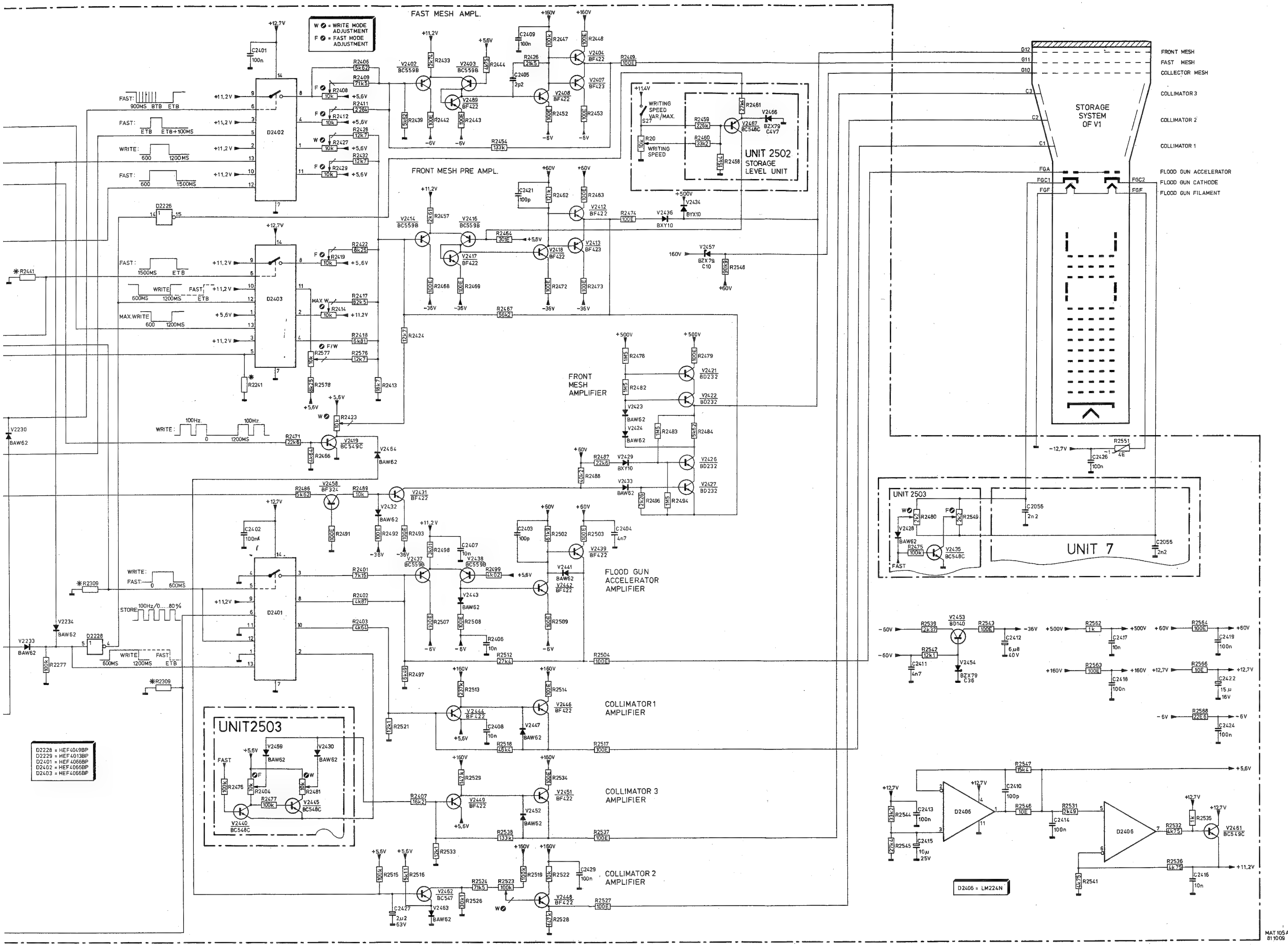
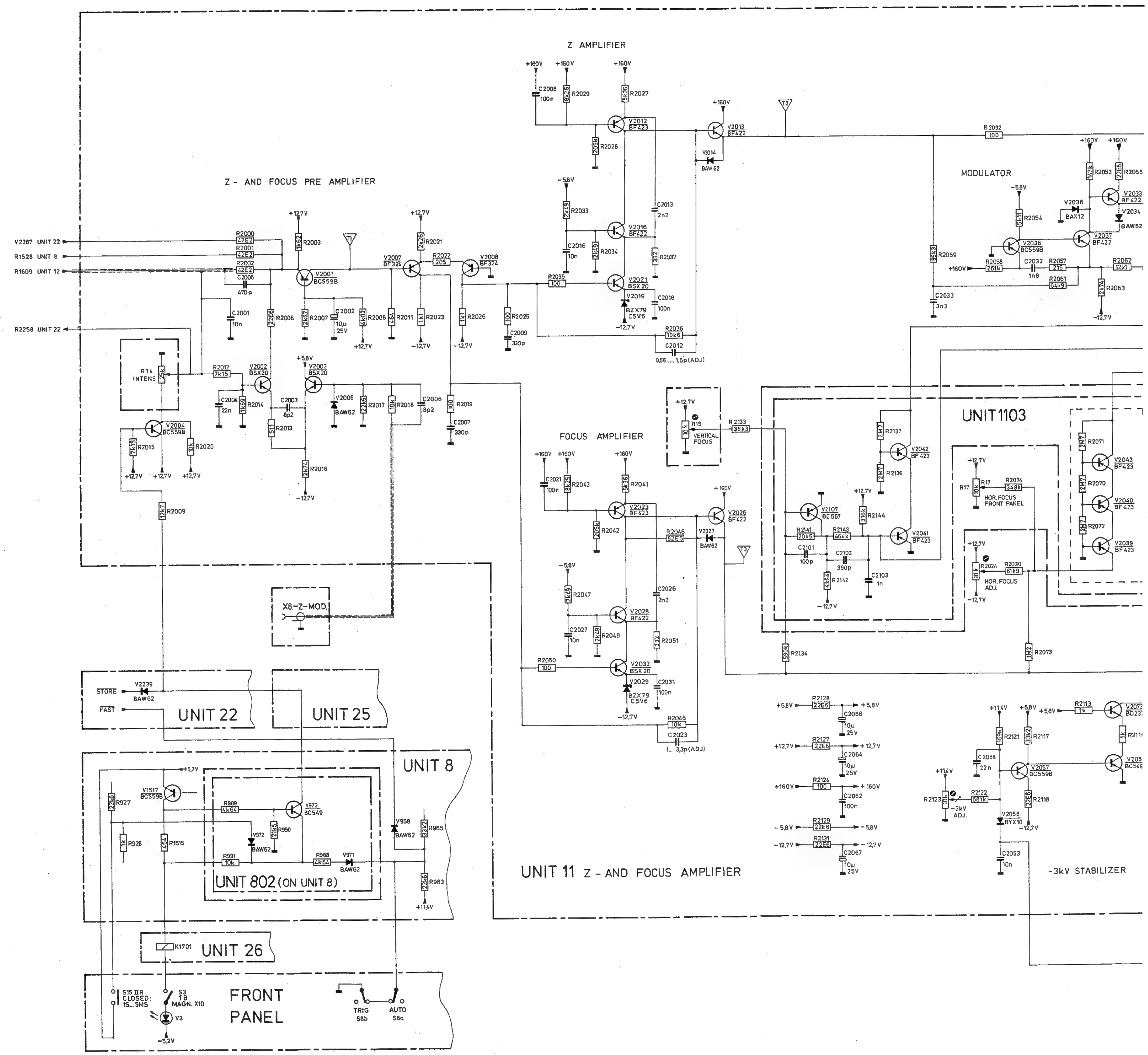
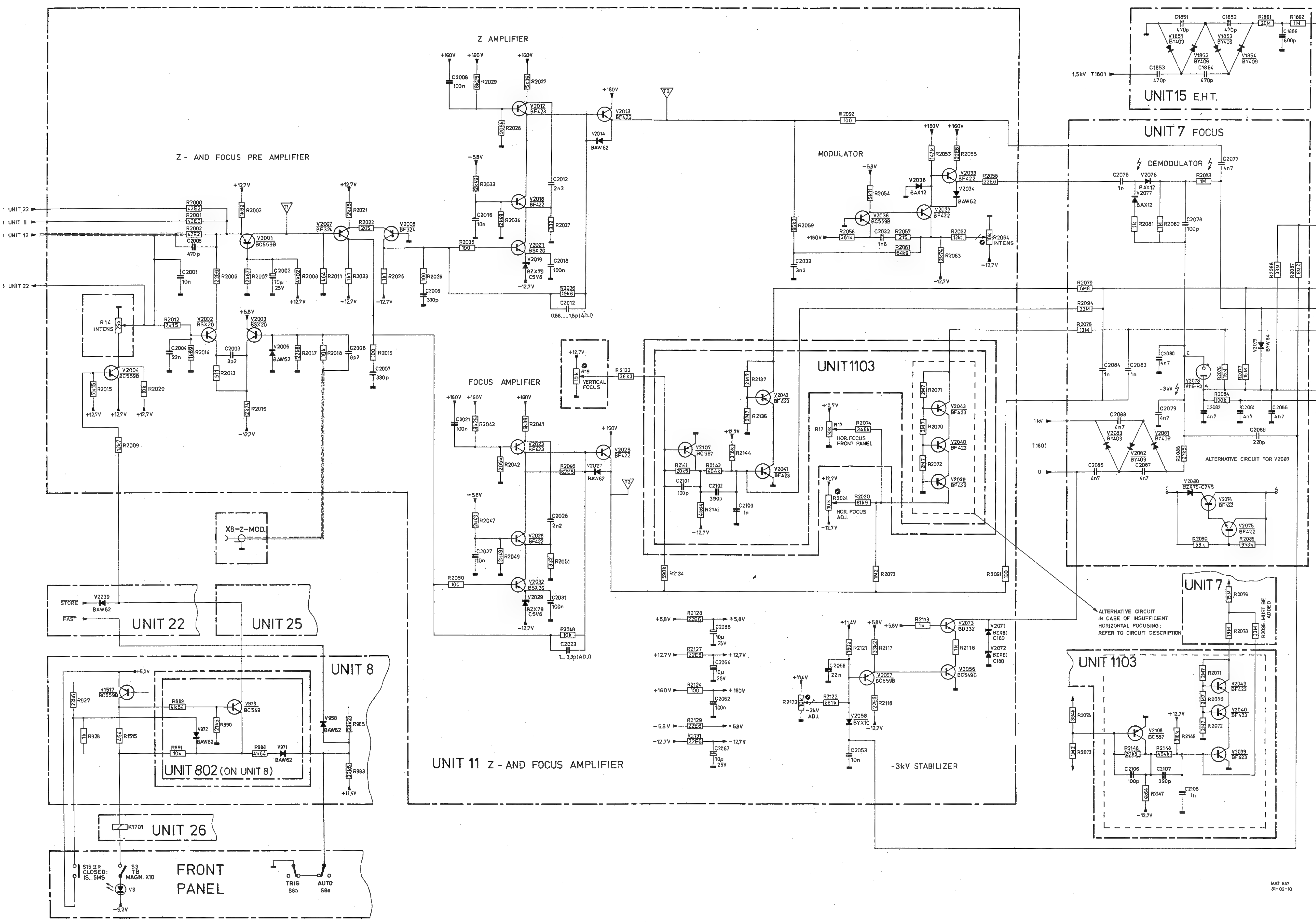
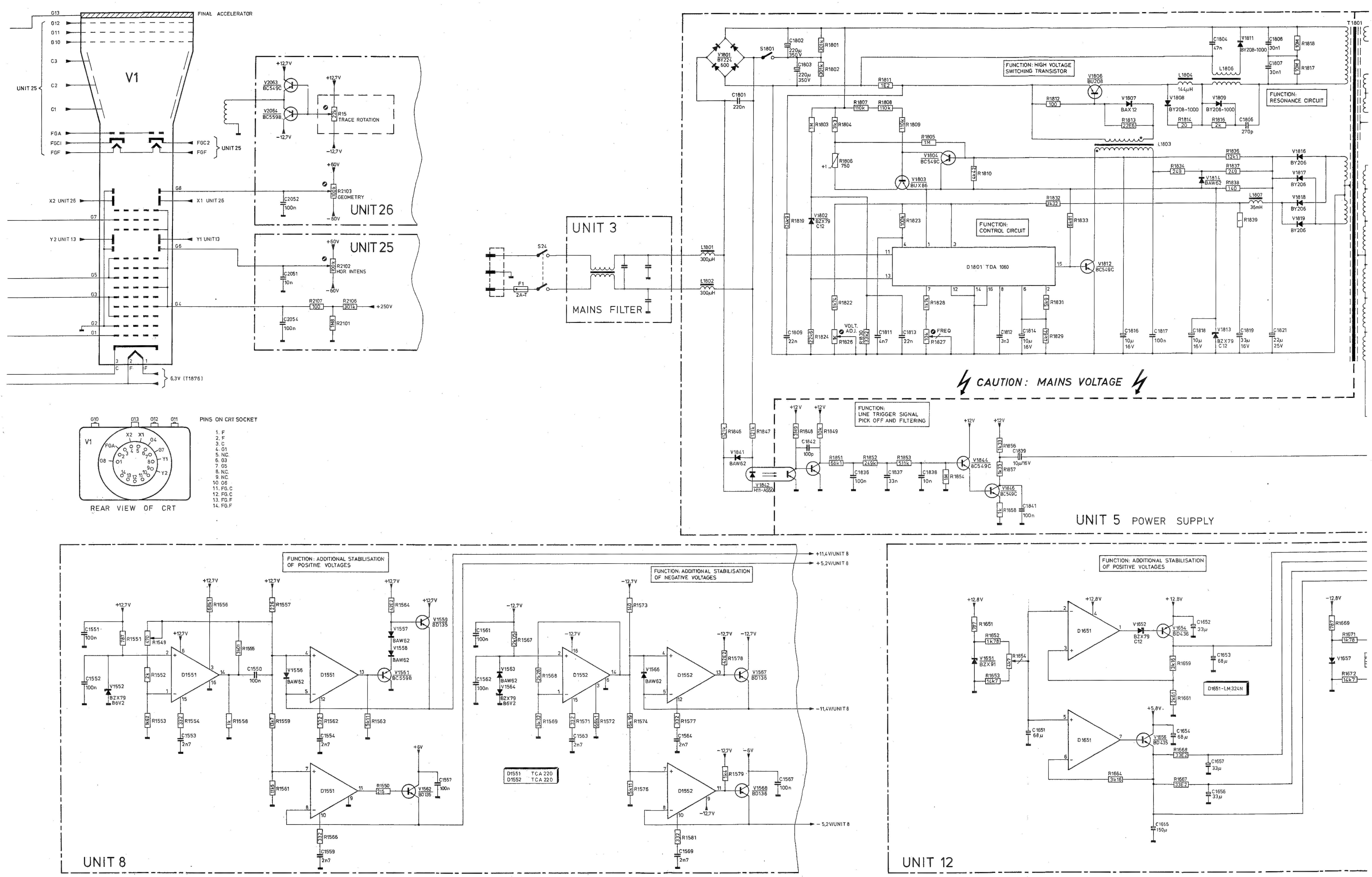


Fig. 12.19. Storage system, circuit diagram


Z AMPLIFIER
Z - AND FOCUS PRE AMPLIFIER
FOCUS AMPLIFIER
MODULATOR
UNIT 1103
UNIT 22
UNIT 25
UNIT 8
UNIT 802 (ON UNIT 8)
UNIT 26
FRONT PANEL
X8-Z-MOD.
UNIT 11 Z - AND FOCUS AMPLIFIER
-3kV STABILIZER
V2267 UNIT 22
R1528 UNIT 8
R1609 UNIT 12
R2258 UNIT 22
R14 INTENS
R19 VERTICAL FOCUS
R17 HOR. FOCUS FRONT PANEL
R2024 HOR. FOCUS ADJ.
STORE
FAST
TRIG S8b
AUTO S8a



MAT 847
81-02-10



FINAL ACCELERATOR
V1
UNIT 25
UNIT 26
TRACE ROTATION
GEOMETRY
HOR INTENS
6,3V (T1876)
PINS ON CRT SOCKET
1. F
2. F
3. C
4. G1
5. N.C.
6. G3
7. G5
8. N.C.
9. N.C.
10. G6
11. FG.C
12. FG.C
13. FG.F
14. FG.F
REAR VIEW OF CRT
UNIT 3
MAINS FILTER
FUNCTION: HIGH VOLTAGE SWITCHING TRANSISTOR
FUNCTION: RESONANCE CIRCUIT
FUNCTION: CONTROL CIRCUIT
D1801 TDA 1060
CAUTION: MAINS VOLTAGE
FUNCTION: LINE TRIGGER SIGNAL PICK OFF AND FILTERING
UNIT 5 POWER SUPPLY
FUNCTION: ADDITIONAL STABILISATION OF POSITIVE VOLTAGES
FUNCTION: ADDITIONAL STABILISATION OF NEGATIVE VOLTAGES
D1551 TCA 220
D1552 TCA 220
UNIT 8
FUNCTION: ADDITIONAL STABILISATION OF POSITIVE VOLTAGES
D1651-LM324N
UNIT 12

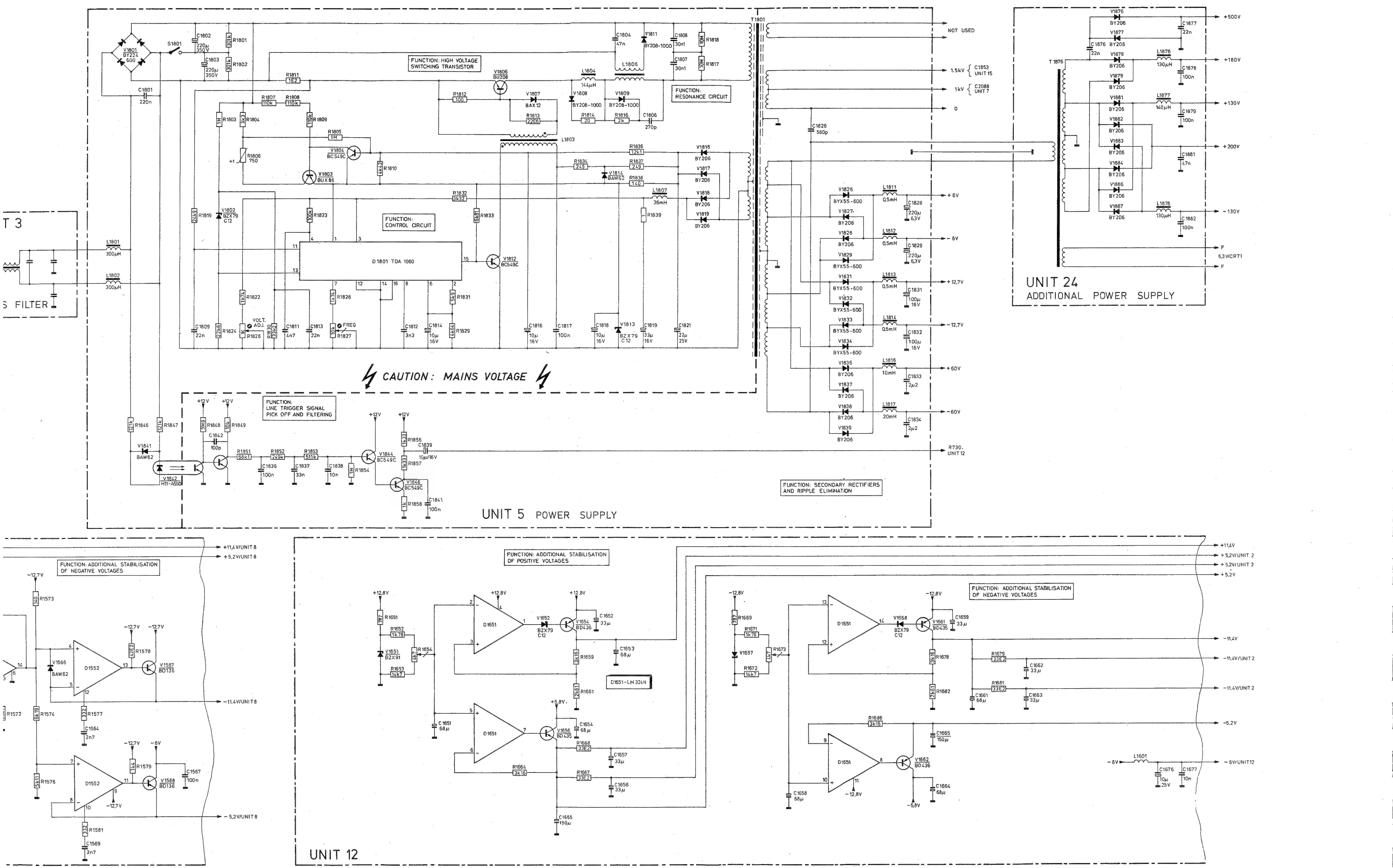


Fig. 12.20. Z-amplifier, focus and power supply, circuit diagram

13. VOLTAGE WAVEFORMS IN THE INSTRUMENT

13.1. INTRODUCTION

The waveforms given in this chapter are typical values and represent the values for an average instrument. So the values measured in your unit under test can differ slightly from the values given in this manual. The waveforms are listed in 3 chapters: vertical deflection (chapter 13.2.), horizontal deflection (chapter 13.3.) and CRT display section (chapter 13.4.). If for instance a fault is expected in the horizontal display section check the waveforms in chapter 13.2. The test must be started with the first waveform in the chapter.
The waveforms and test patterns that can be measured in the storage section of the instrument are given in fig. 6.15., 6.16., 6.17 and in the storage section circuit diagram.
Many of the test points are marked on the units and are provided with attachment points for a measuring probe.

The required test equipment for measureing the waveforms is an oscilloscope with a bandwidth of 50 MHz or more (e.g. Philips PM3240) with a suitable 10:1 attenuator probe. The input square wave signal for the instrument under test can be obtained from a function generator (e.g. Philips PM5127).

The instrument under test has the following settings of the controls (unless otherwise indicated):
- Push the Y-position controls to the normal (non inverted) position.
- Put the signal coupling switches of channel A and B in the DC-position.
- Depress push-button A of the vertical display mode selector.
- Put the channel A and B AMPL/DIV switch in the 1V/DIV position and their vernier controls to CAL.
- Depress push-button MAIN TB of the horizontal display mode selector.
- Push the TB MAGN control to the X1-position.
- Depress push-button AUTO of the trigger mode selector.
- Put the main time-base TIME/DIV switch in the 20 μs/DIV position and its vernier control to CAL.
- Put the delayed time-base TIME/DIV switch in the OFF-position and its vernier control to CAL.
- Depress push-button DC of the main and delayed time-base trigger coupling controls.
- Depress push-button A of the main and delayed time-base trigger source controls.
- Apply a square-wave voltage of 6Vp.p/10 kHz to the input socktes of channel A and B.
- Put the signal in the middle of the screen by means of the channel A and B position controls.
- Put the variable HOLD OFF control in the CAL position.

The measuring oscilloscope has the following settings of the controls (unless otherwise indicated):
- The waveforms are measured on channel A; the required AMPL/DIV position is indicated.
- The vertical position of the main time base line without input signal is indicated in the waveform diagram with "O".
- The instrument is triggered on the signal available on test point T1 on unit 2 (attenuator unit). This signal can be applied to channel B with the AMPL/DIV switch in the 0,1V/DIV position.
- Only the main time-base is used and the required TIME/DIV position is indicated.
- The signal coupling control occupies the AC position.
- The main time-base trigger coupling control occupies the DC position.

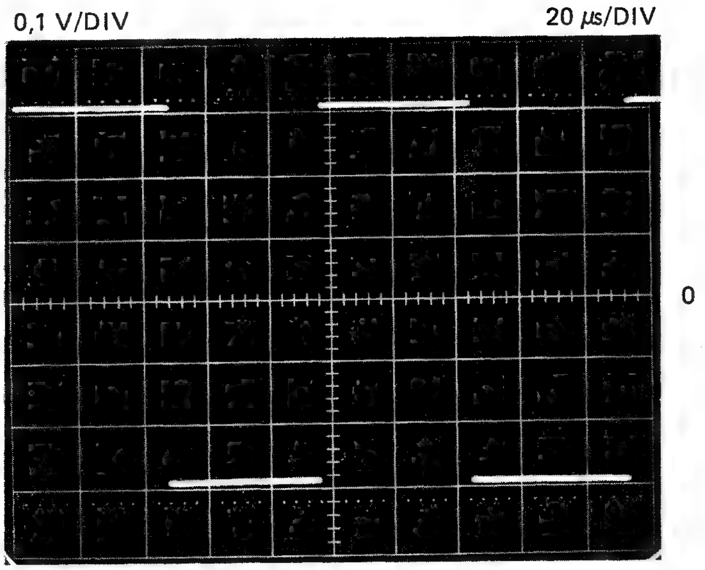
The units on which voltage waveforms can be measured are:

unit 2	=	attenuator unit
unit 12	=	intermediate amplifier
unit 13	=	final vertical amplifier
unit 9	=	trigger amplifier
unit 8	=	time-base unit
unit 26	=	final horizontal amplifier
unit 11	=	Z-amplifier

13.2. VERTICAL DEFLECTION

UNIT 2

T1



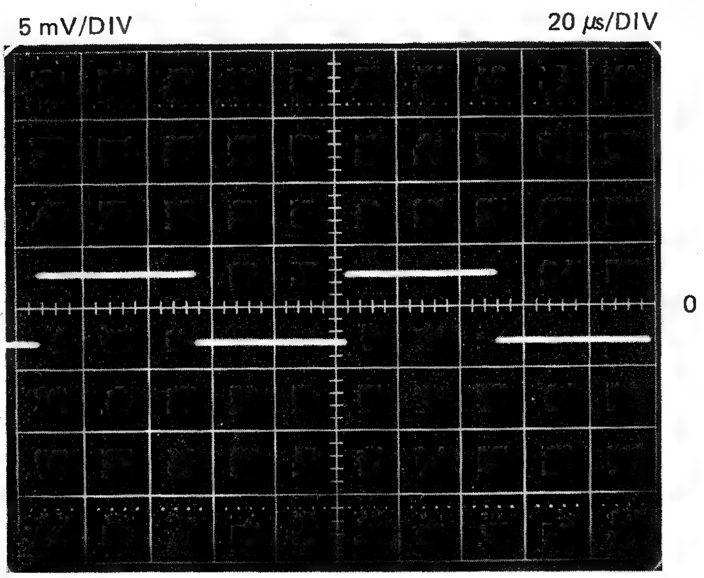
measuring oscilloscope:

– DC signal coupling.

UNIT 12

T1

T2



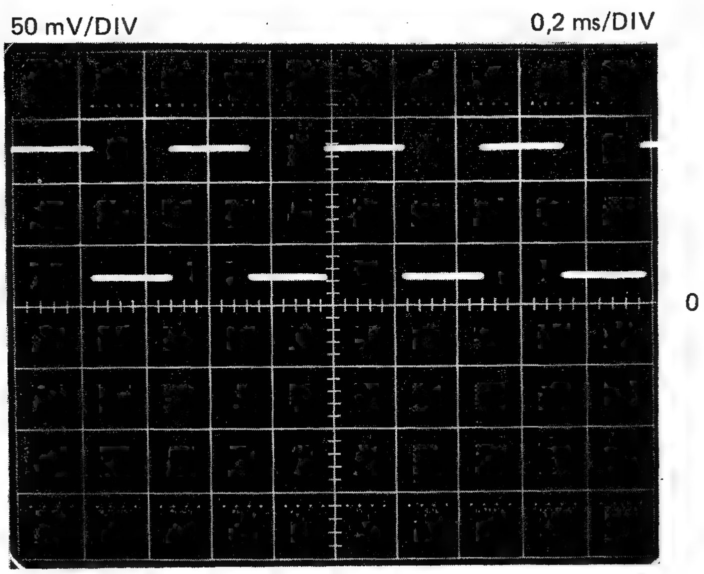
measuring oscilloscope:

– DC signal coupling.

UNIT 12

T9

T10



measuring oscilloscope:

– triggering on signal on test point T9/T10 of unit 12.

– DC signal coupling.

oscilloscope under test:

– no input signal.

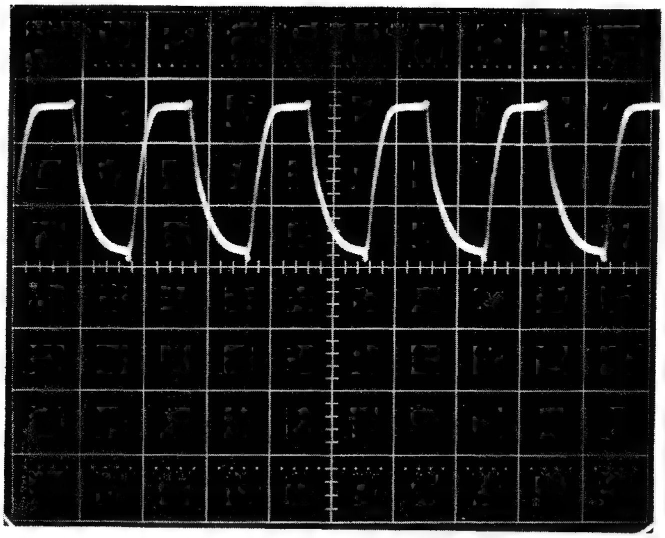
– push-button ALT of vertical display mode depressed.

UNIT 12

T9

T10

50 mV/DIV 0,5 μs/DIV



0

measuring oscilloscope:

- triggering on signal on test point T9/10 of unit 12.
- DC signal coupling.

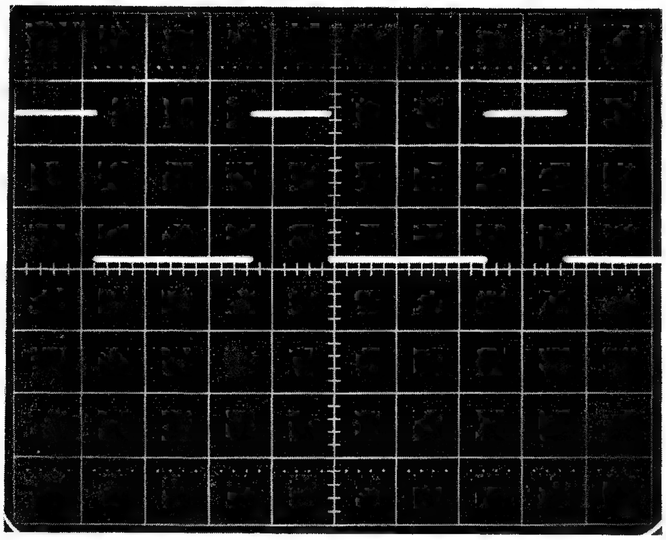
oscilloscope under test:

- no input signal.
- push-button CHOP of vertical display mode depressed.

UNIT 12

T11

50 mV/DIV 0,2 ms/DIV



0

measuring oscilloscope:

- triggering on signal on test point T11 of unit 12.
- DC signal coupling.

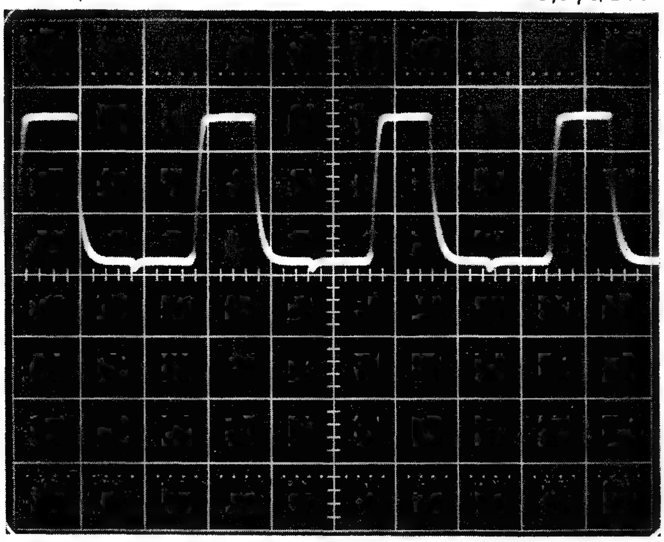
oscilloscope under test:

- no input signal.
- push-buttons ALT and TRIG VIEW of vertical display mode simultaneously depressed.

UNIT 12

T11

50 mV/DIV 0,5 μs/DIV



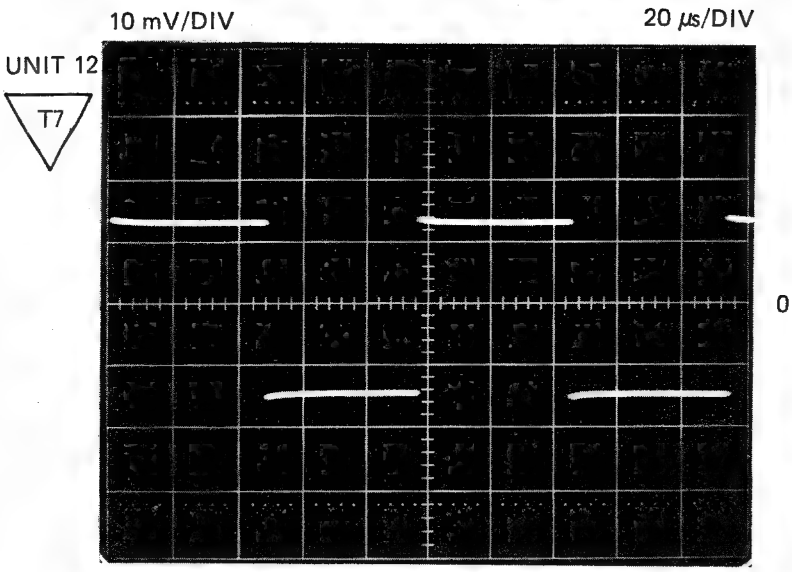
0

measuring oscilloscope:

- triggering on signal on test point T11 of unit 12.
- DC signal coupling.

oscilloscope under test:

- no input signal.
- push-buttons CHOP and TRIG VIEW of vertical display mode simultaneously depressed.

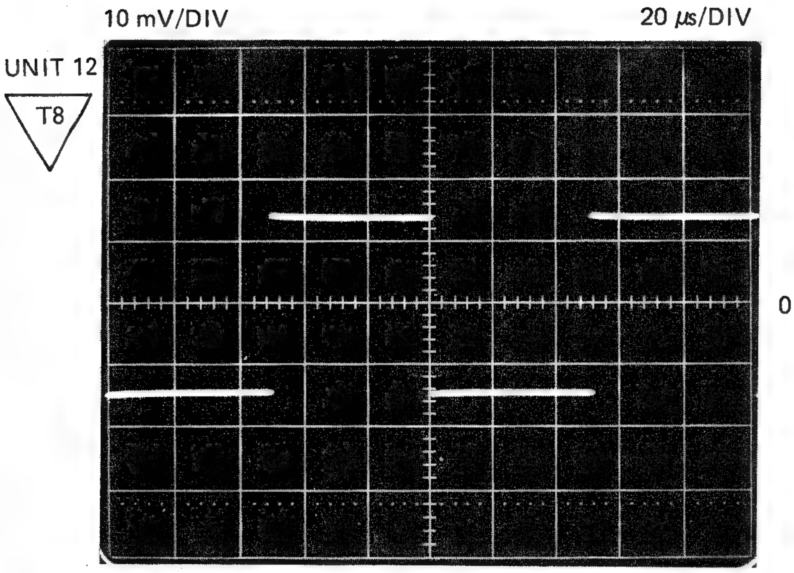


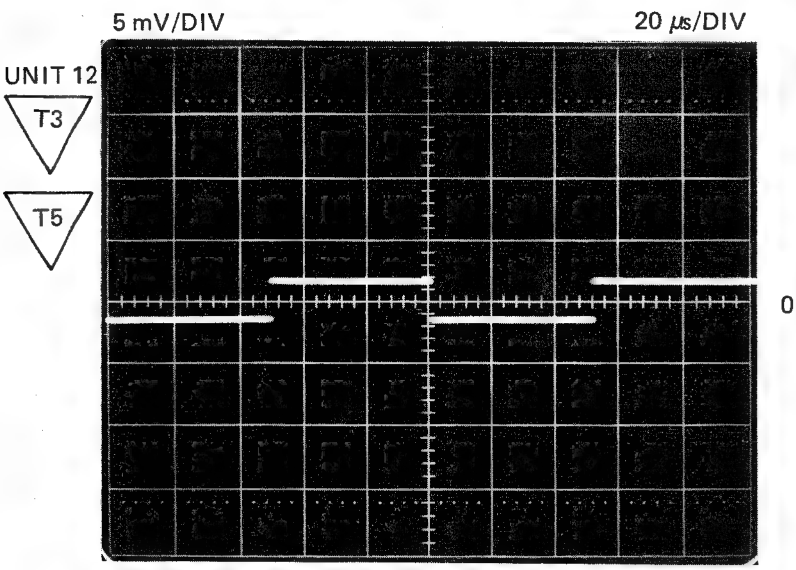
measuring oscilloscope:

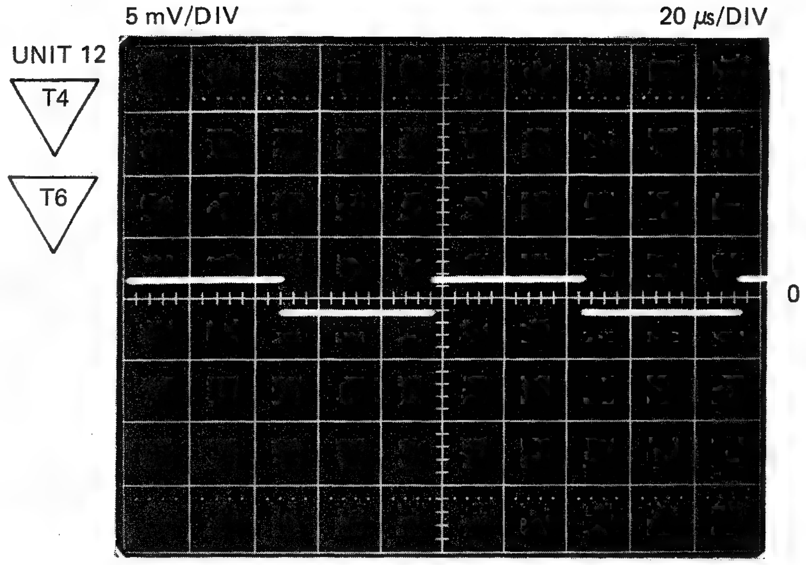
— other settings as indicated in introduction.

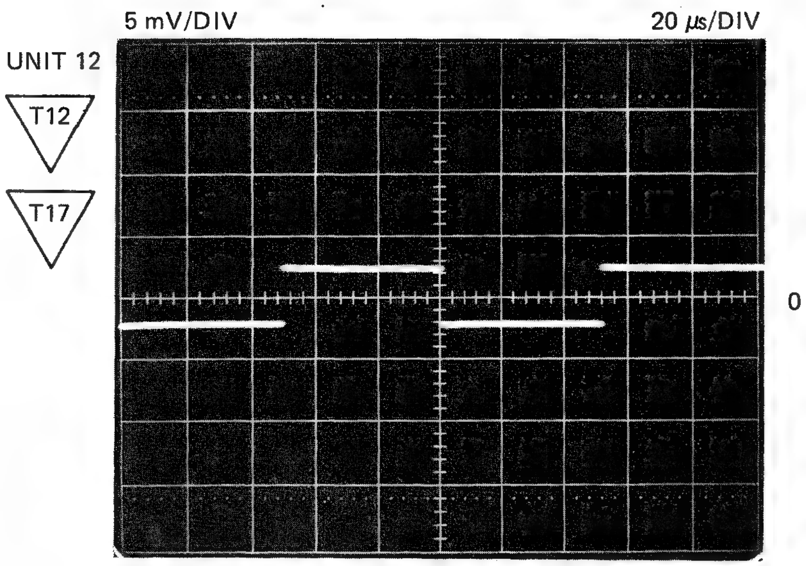
oscilloscope under test:

— settings as indicated in introduction.



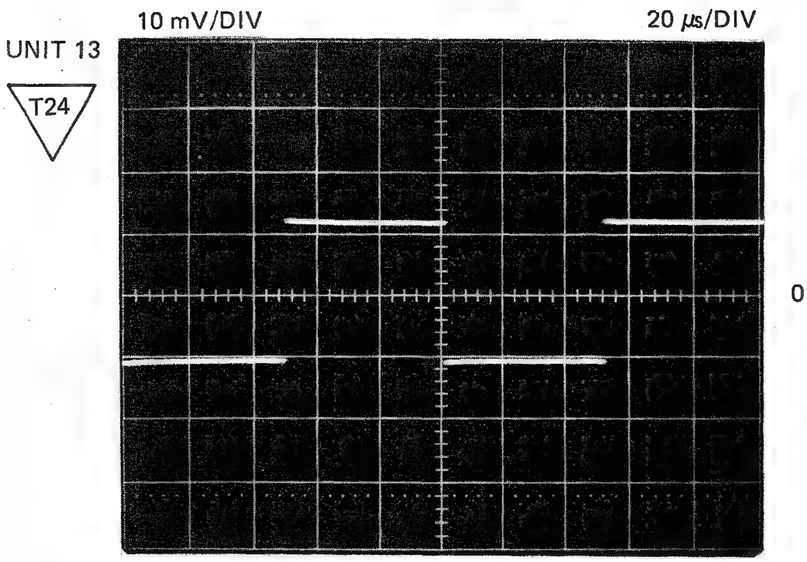






oscilloscope under test:

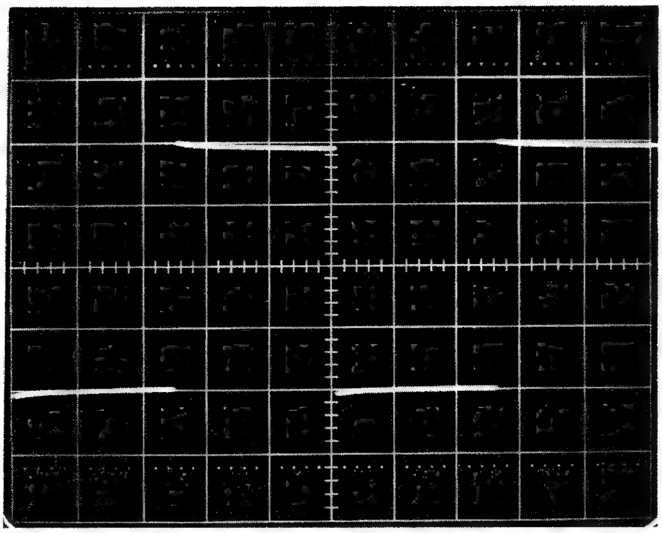
- depress push-button A or B on the main and delayed time base trigger source selector.



10 mV/DIV 20 μs/DIV

UNIT 13

T26

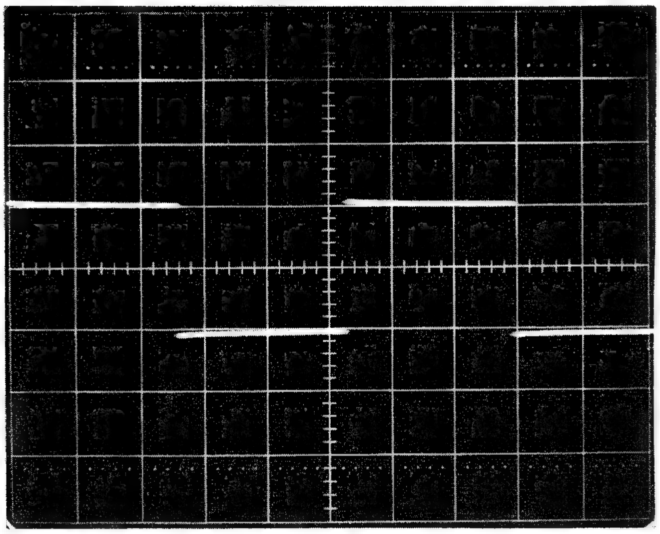


0

10 mV/DIV 20 μs/DIV

UNIT 13

T25

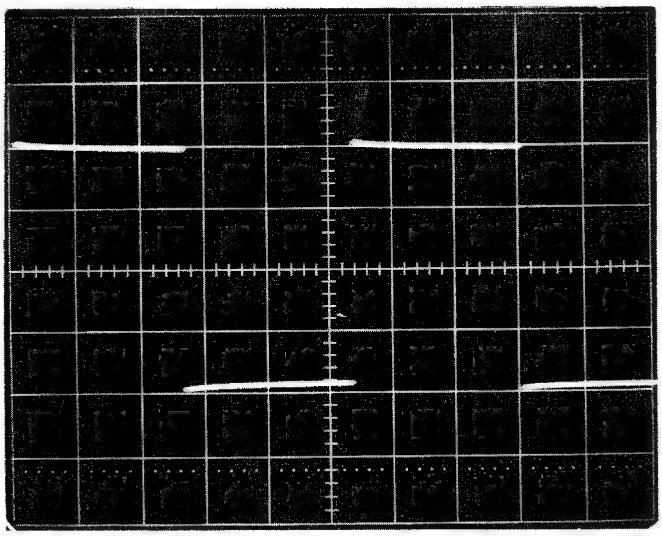


0

10 mV/DIV 20 μs/DIV

UNIT 13

T27

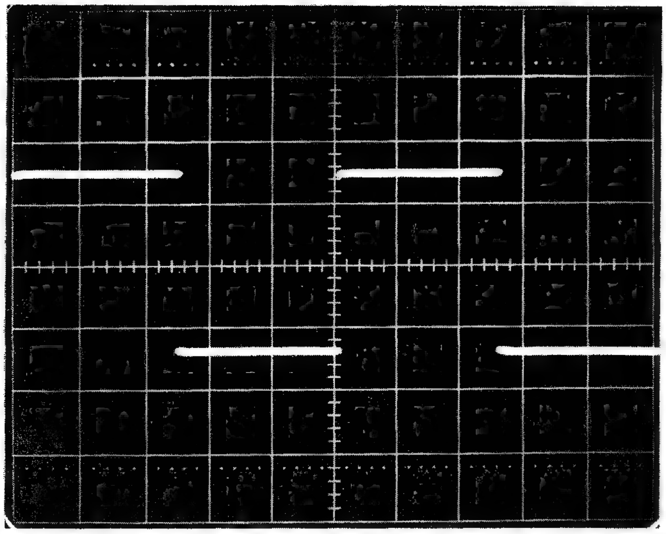


0

0,5 V/DIV 20 μs/DIV

UNIT 13

T28



0

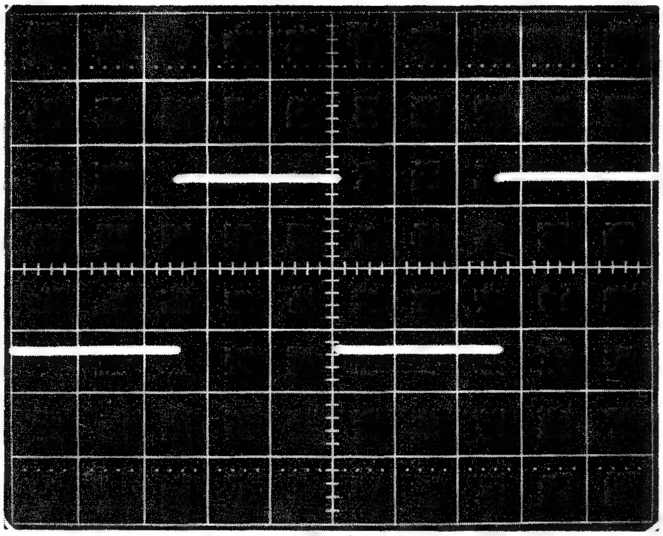
oscilloscope under test:

– Voltage must be measured on side connection of CRT. Do this very careful: if the side pins are bent, the CRT is likely to develop a gas leak.

0,5 V/DIV 20 μs/DIV

UNIT 13

T29

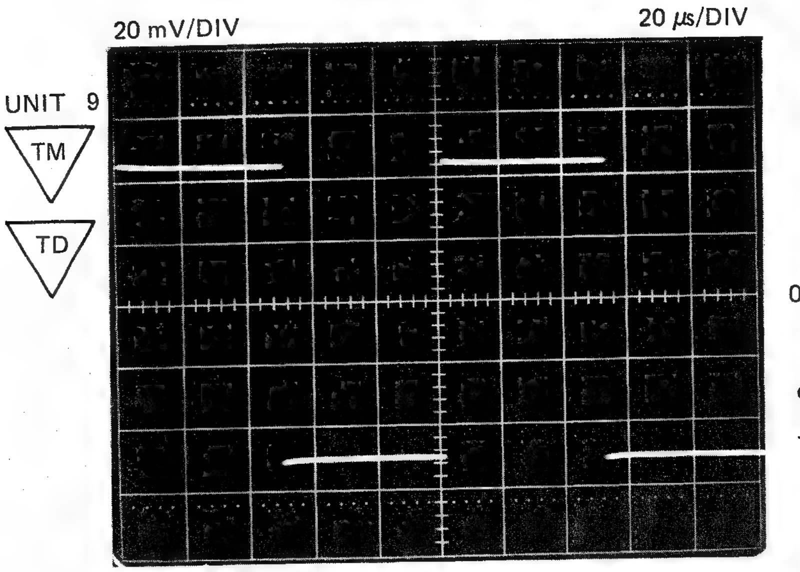


0

oscilloscope under test:

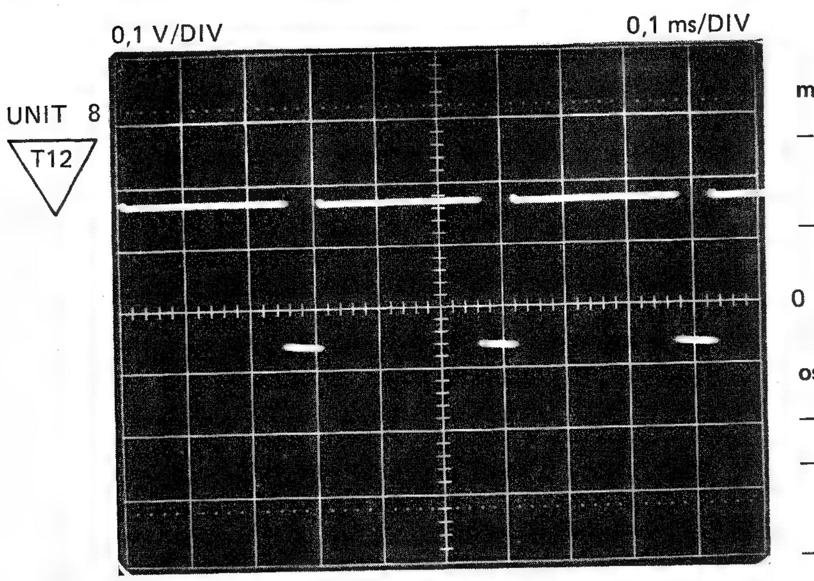
– Voltage must be measured on side connection of CRT. Do this very careful: if the side pins are bent, the CRT is likely to develop a gas leak.

13.3. HORIZONTAL DEFLECTION



oscilloscope under test:

– Put the main and delayed time-base LEVEL controls in their mid-position.



measuring oscilloscope:

– Triggering on signal on test point T12 of unit 8.

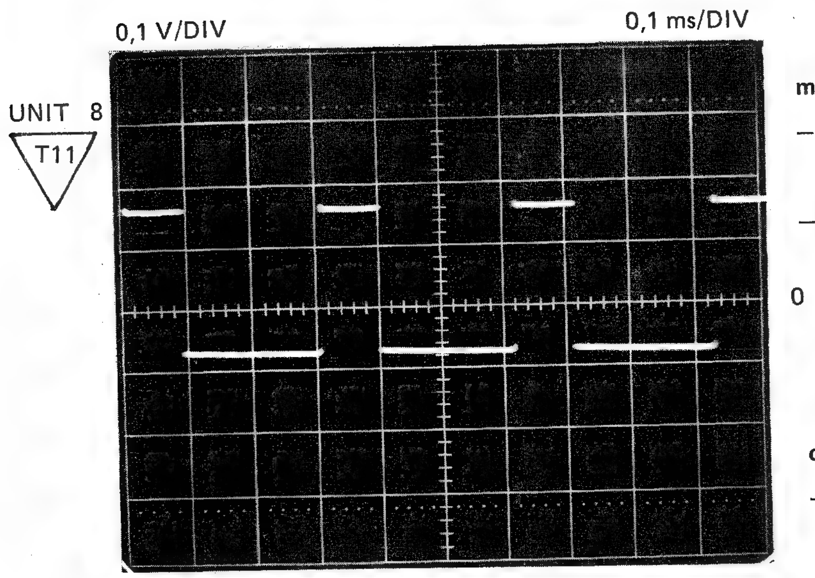
– DC signal coupling.

oscilloscope under test:

– No input signal.

– Depress push-button MAIN TB of delayed time-base trigger source switch.

– Put the delayed time-base TIME/DIV switch in the 5 μs/DIV position.



measuring oscilloscope:

– Triggering on signal on test point T11 of unit 8.

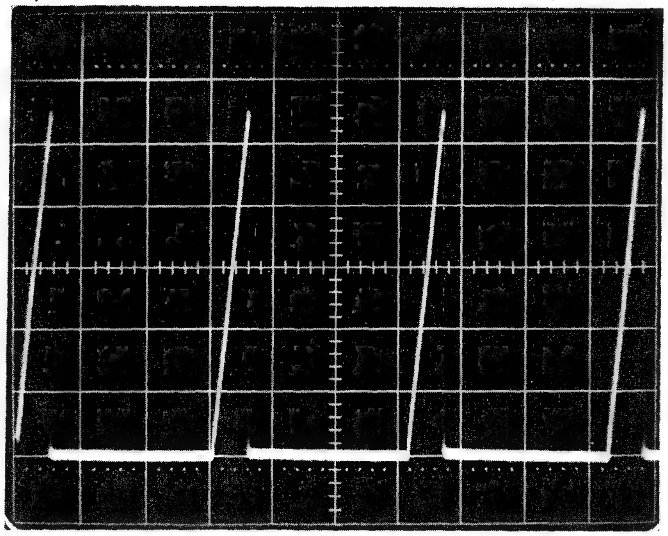
– DC signal coupling.

oscilloscope under test:

– No input signal.

UNIT 8

T13



measuring oscilloscope:

– Triggering on signal on test point T13 of unit 8.

– DC signal coupling.

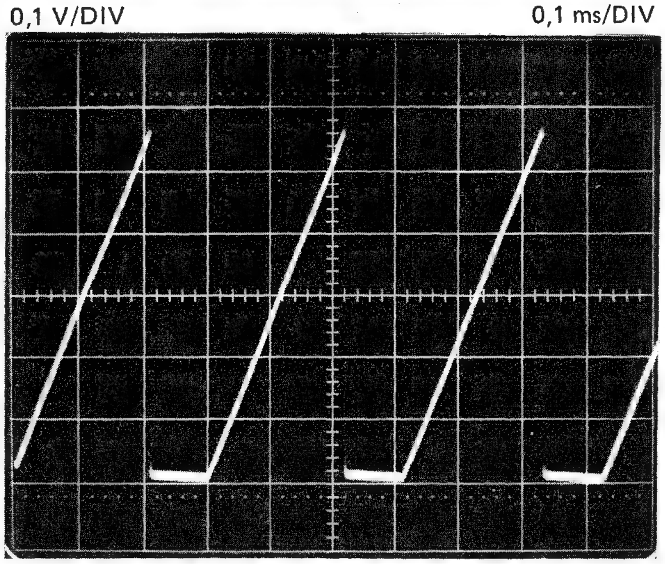
oscilloscope under test:

– No input signal.

– Put the delayed time-base TIME/DIV switch in the 5µs/DIV position.

UNIT 8

T17



measuring oscilloscope:

– Triggering on signal on test point T17 of unit 8.

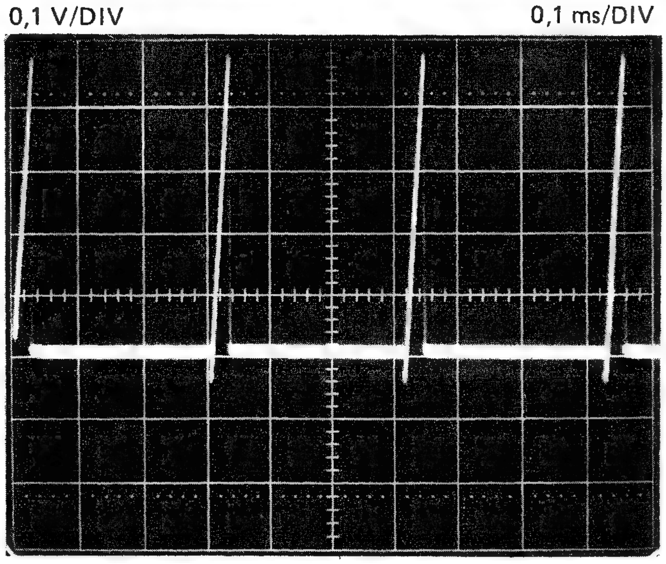
– DC signal coupling.

oscilloscope under test:

– No input signal.

UNIT 8

T16



measuring oscilloscope:

– Triggering on signal on test point T16 of unit 8.

– DC signal coupling.

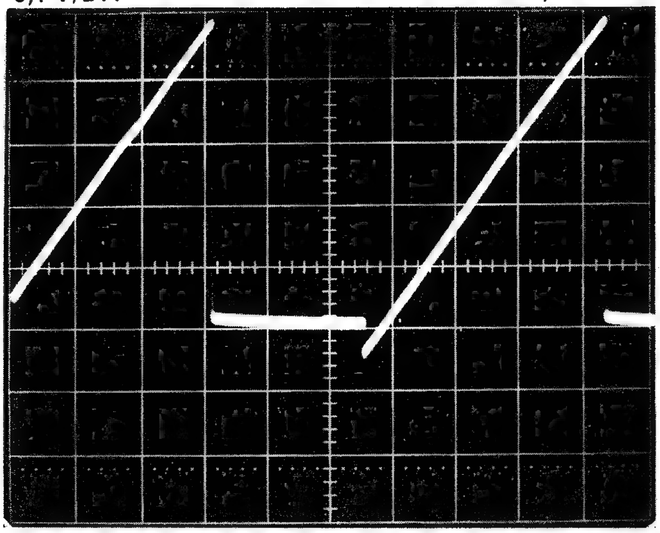
oscilloscope under test:

– No input signal.

0,1 V/DIV 0,1 ms/DIV

UNIT 8

T16



0

measuring oscilloscope:

– Triggering on signal on test point T16 of unit 8.

– DC signal coupling.

oscilloscope under test:

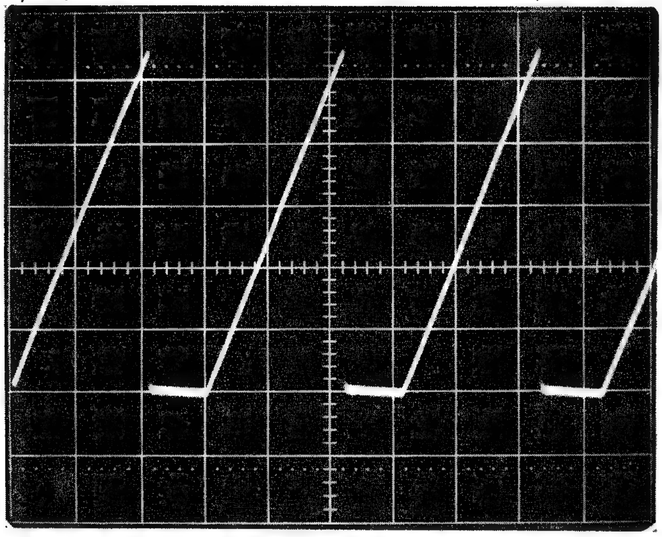
– No input signal.

– HOLD OFF control fully anti-clockwise.

0,1 V/DIV 0,1 ms/DIV

UNIT 8

T3



0

measuring oscilloscope:

– Triggering on signal on test point T3 of unit 8.

– DC signal coupling.

oscilloscope under test:

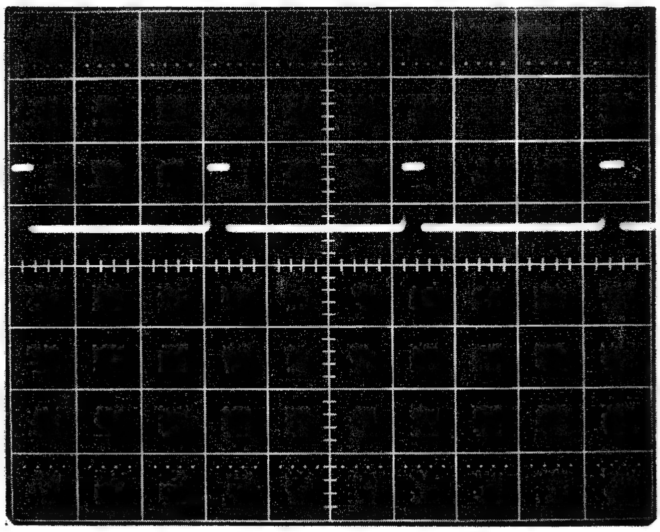
– No input signal.

– Put the HOLD OFF control in the CAL position.

0,1 V/DIV 0,1 ms/DIV

UNIT 8

T15



0

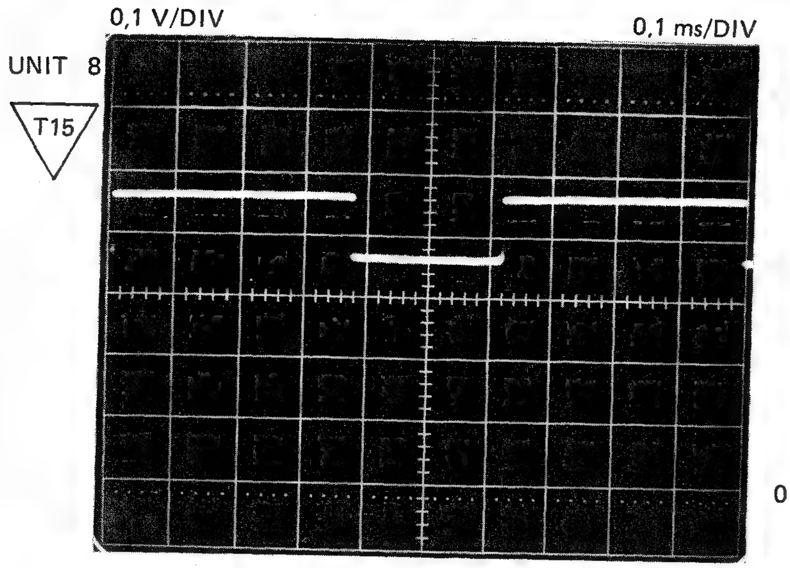
measuring oscilloscope:

– Triggering on signal on test point T15 of unit 8.

– DC signal coupling.

oscilloscope under test:

– No input signal.

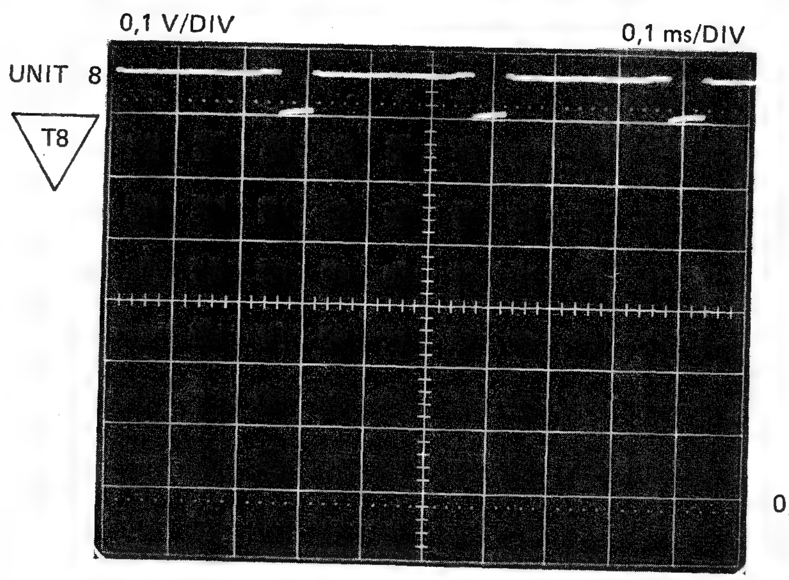


measuring oscilloscope:

- Triggering on signal on test point T15 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- HOLD OFF control fully anti-clockwise.

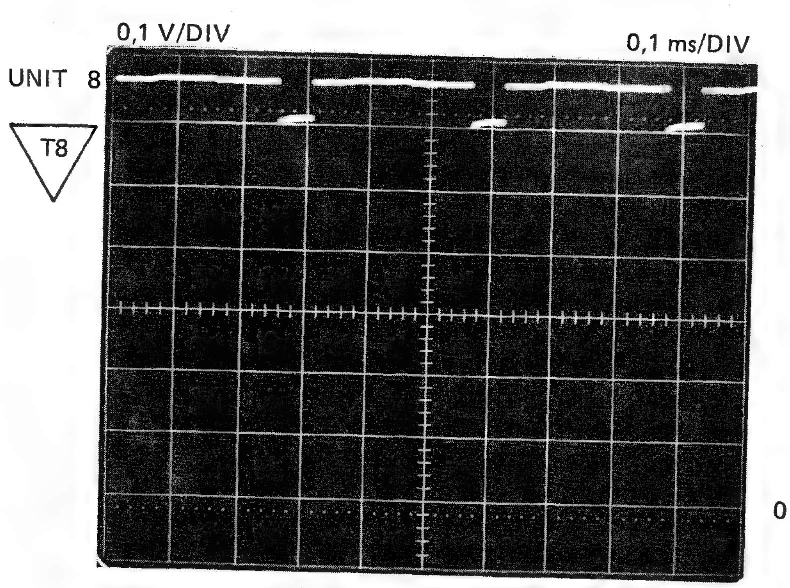


measuring oscilloscope:

- Triggering on signal on test point T8 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Put the HOLD OFF control in the CAL position.
- Put the delayed time-base TIME/DIV switch in the 5 μs/DIV position.
- Depress push-button MAIN TB of the delayed time-base trigger source selector.
- Adjust DELAY TIME control to 0,0.



measuring oscilloscope:

- Triggering on signal on test point T8 of unit 8.
- DC signal coupling.

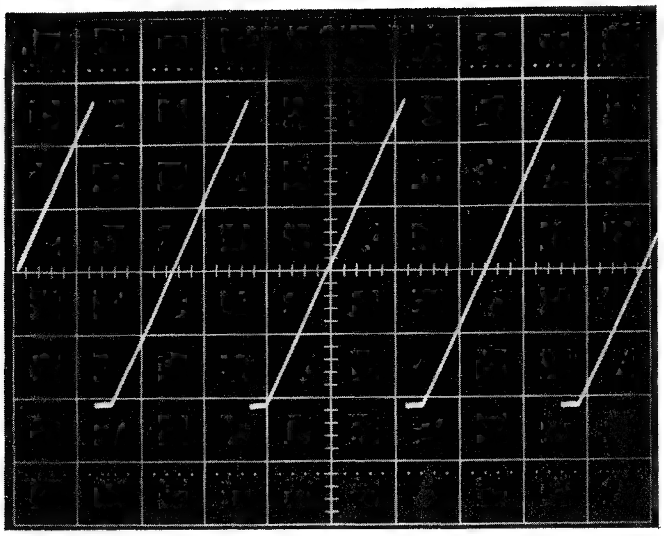
oscilloscope under test:

- No input signal.
- Adjust the DELAY TIME control to 5,0.

2 V/DIV 0,1 ms/DIV

UNIT 26

T18



measuring oscilloscope:

- Triggering on signal on test point T18 of unit 26.
- DC signal coupling.

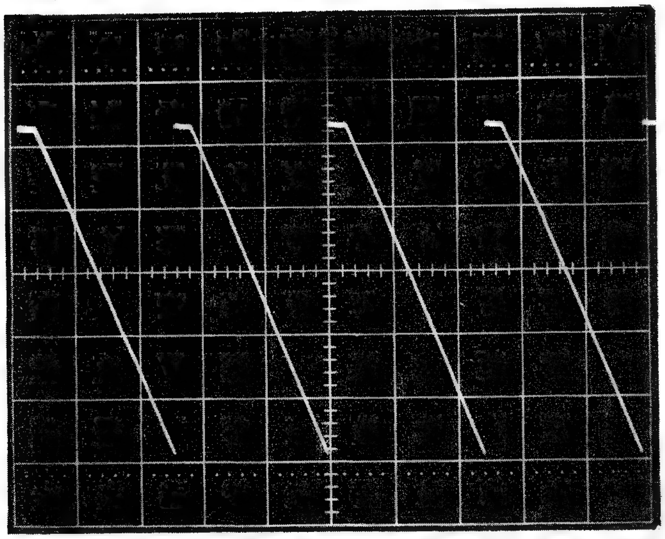
oscilloscope under test:

- No input signal.

2 V/DIV 0,1 ms/DIV

UNIT 26

T19



measuring oscilloscope:

- Triggering on signal on test point T19 of unit 26.
- DC signal coupling.

oscilloscope under test:

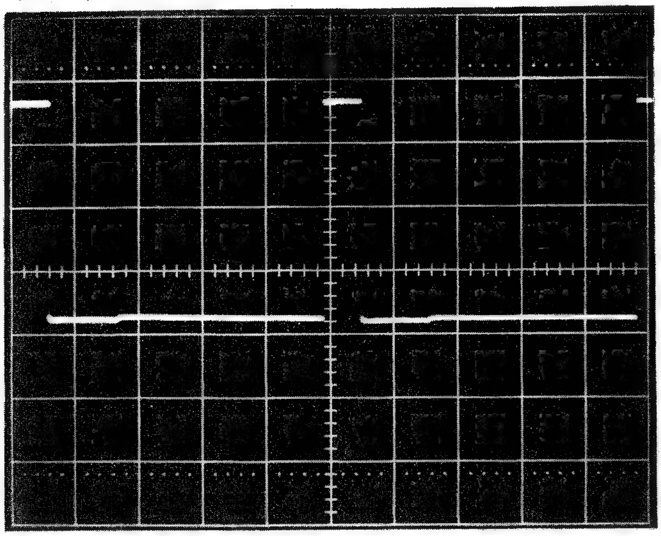
- No input signal.

13.4. WAVEFORMS IN CRT-DISPLAY SECTION

50 mV/DIV 50 µs/DIV

UNIT 11

T1



0

measuring oscilloscope:

- Triggering on signal on test point T1 of unit 11.
- DC signal coupling.

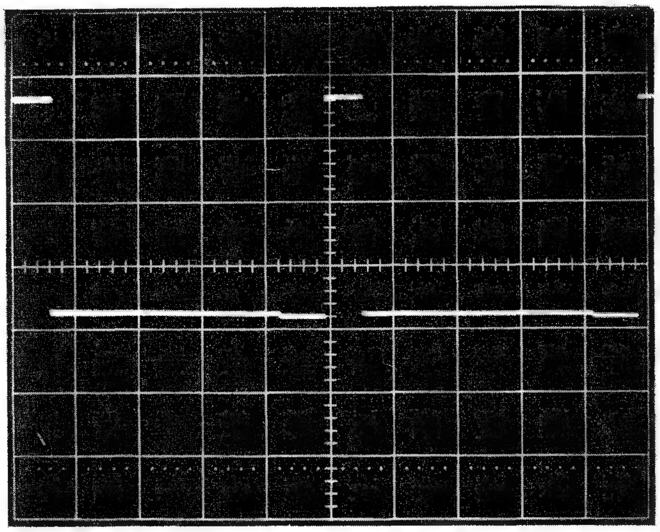
oscilloscope under test:

- No input signal.
- Adjust to minimum intensity.
- Depress push-button MAIN TB of delayed time-base trigger source selector.
- Put the delayed time-base TIME/DIV switch in the 5 µs/DIV position.
- Adjust the DELAY TIME control to 0.

50 mV/DIV 50 µs/DIV

UNIT 11

T1



0

measuring oscilloscope:

- Triggering on signal on test point T1 of unit 11.
- DC signal coupling.

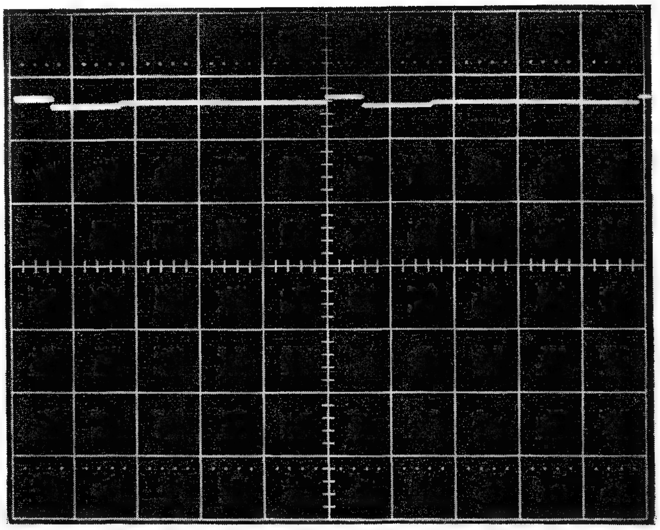
oscilloscope under test:

- No input signal.
- Adjust the DELAY TIME control to 9.

0,5 V/DIV 50 µs/DIV

UNIT 11

T3



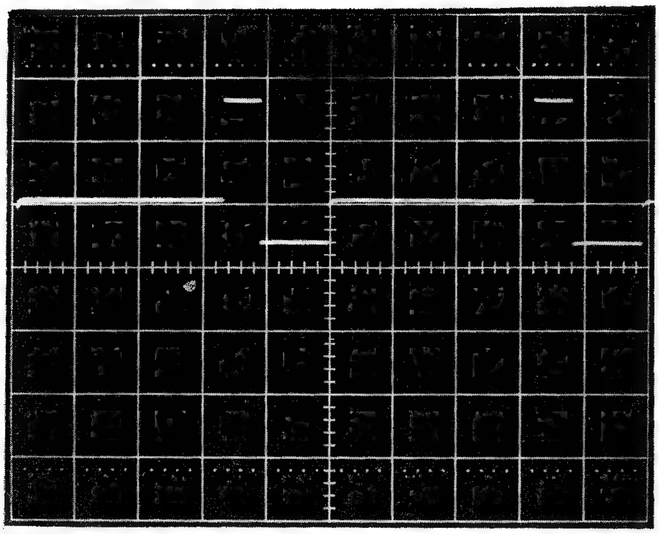
0

measuring oscilloscope:

- Triggering on signal on test point T3 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the DELAY TIME control to 0.



measuring oscilloscope:

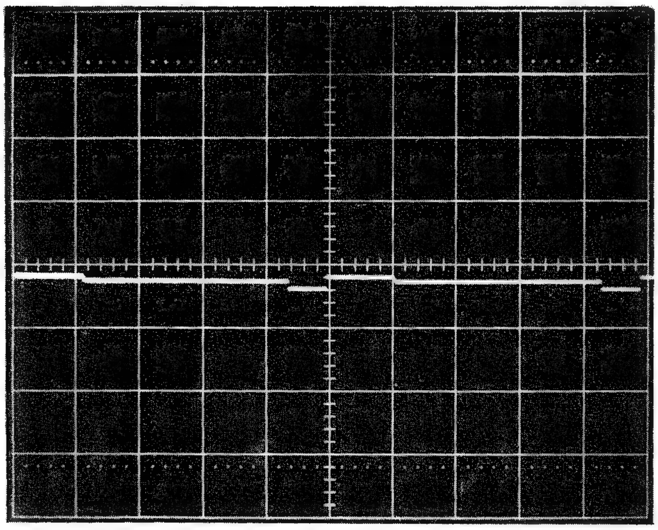
– Triggering on signal on test point T3 of unit 11.

– DC signal coupling.

oscilloscope under test:

– No input signal.

– Adjust the intensity control to maximal intensity.



measuring oscilloscope:

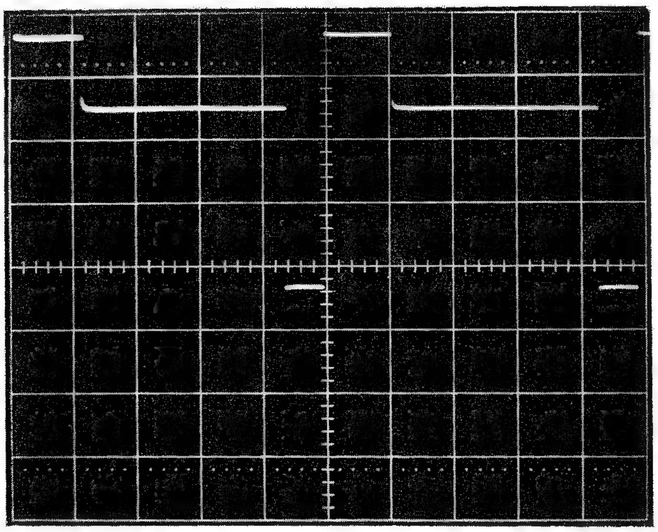
– Triggering on signal on test point T2 of unit 11.

– DC signal coupling.

oscilloscope under test:

– No input signal.

– Adjust the intensity control to minimal intensity.



measuring oscilloscope:

– Triggering on signal on test point T2 of unit 11.

– DC signal coupling.

oscilloscope under test:

– No input signal.

– Adjust the intensity control to maximal intensity.

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
3 2	1 5 0 4 7 5	O P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ [| | 1 | 2] Hrs

Detailed description of the information to be entered in the various boxes:

①Country: [3 2] = Switzerland

②Day Month Year [1 5 0 4 7 5] = 15 April 1975

③Type number/Version [O P M 3 2 6 0 0 2] = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number [D O 0 0 7 8 3] = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box

⑥Coded failure description

Location

[| | |]

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

[| | | | |]

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

- 990000 Unknown/Not applicable
- 990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
- 990002 Knob (incl. dial knob, cap, etc.)
- 990003 Probe (only if attached to instrument)
- 990004 Leads and associated plugs
- 990005 Holder (valve, transistor, fuse, board, etc.)
- 990006 Complete unit (p.w. board, h.t. unit, etc.)
- 990007 Accessory (only those without type number)
- 990008 Documentation (manual, supplement, etc.)
- 990009 Foreign object
- 990099 Miscellaneous

Category

[ ]

- 0 Unknown, not applicable (fault not present, intermittent or disappeared)
- 1 Software error
- 2 Readjustment
- 3 Electrical repair (wiring, solder joint, etc.)
- 4 Mechanical repair (polishing, filing, remachining, etc.)
- 5 Replacement (of transistor, resistor, etc.)
- 6 Cleaning and/or lubrication
- 7 Operator error
- 8 Missing items (on pre-sale test)
- 9 Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.

⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

[| | 1 | 2] = 1,2 working hours (1 h 12 min.)

Sales and service all over the world

Alger: Bureau de Liaison Philips,
24 bis Rue Bougainville,
El Mouradia, Alger; tel.: 565672

Argentina: Philips Argentia S.A.,
Cassila Correo 3479, (Central), 1430 Buenos Aires;
tel. (1)70-12421/70-2325/2905/6488

Australia: Philips Scientific & Industrial
Equipment Division, Centre Court,
25 - 27 Paul Street, P.O. Box 119,
North Ryde/NSW 2113; tel. 888-8222

Bangla Desh: Philips Bangla Desh Ltd.,
P.O. Box 62; Ramna, Dacca; tel. 283332

België/Belgique: M.B.L.E., S.A.,
Philips Scientific and Industrial Equipment Division;
80 Rue des Deux Gares, 1070 Bruxelles;
tel. (2) 523.00.00

Bolivia: Industrias Bolivianas Philips S.A.,
Cajón Postal 2964. La Paz;
tel.: 50029/55270/55604

Brasil: Philips Do Brasil Ltda,
Avenida 9 de Julho 5229; Caixa Postal 8681;
CEP 01407 - Sao Paulo (S.P.);
tel. 2825722
Service Centre:
Sistemas Profissionais
Divisao Tecnica
Rua Amador Bueno, 474,
Caixa Postal 3159 - S. Amaro
CEP 04752 - Sao Paulo (S.P.);
tel. 2476522

Canada: Philips Test and Measuring Instruments Inc.,
6 Leswyn Road,
Toronto (Ontario) M6A-1K2;
tel. (416) 789-7188

Chile: Philips Chiléna S.A.,
Division Professional, Avda. Santa Maria 0760;
Casilla Postal 2687, Santiago de Chile; tel. 770038

Colombia: Industrias Philips de Columbia S.A.,
Calle 13 no. 51—39, Apartado Aereo 4282,
Bogota; tel. 2600600

Danmark: Philips Elektronik-Systemer A/S,
Afd. for Industri og Forskning; Strandlodsvej 4,
P.O. Box 1919, 2300 København S,
tel. (1) 572222

Deutschland (Bundesrepublik): Philips GmbH,
Unternehmensbereich Elektronik für
Wissenschaft und Industrie,
Postfach 310 320; 35 Kassel-Bettenhausen,
Miramstrasse 87; tel. (561) 5011

Ecuador: Philips Ecuador S.A.,
Casilla 343, Quito; tel. 239080

Egypt: Resident Delegate Office of Philips Industries,
5 Sherif Street, Corner Eloui. P.O. Box 1687, Cairo;
tel. 754118/754259/754077.

Eire: Philips Electrical (Ireland) Ltd.
Newstead, Clonskeagh, Dublin 14; tel. (1) 693355

España: Philips Ibérica S.A.E.,
Dpto Aparatos de Medida, Martinez Villergas 2,
Apartado 2065, Madrid 27;
tel (1) 4042200
Service Centre:
Dpto Tco. de Instrumentación,
Calle de Albasanz 75, Madrid 17;
tel. (1) 2047100

Ethiopia: Philips Ethiopia (Priv. Ltd. Co.),
Ras Abebe Areguay Avenue,
P.O.B. 2565,
Addis Ababa; tel. 448300

Finland: See Suomi

France: S.A. Philips Industrielle et Commerciale,
Division S&I,
105 Rue de Paris, 93 002 Bobigny;
tel. (1) 8301111

Great Britain: Pye Unicam Ltd., York Street,
Cambridge CB1-2PX, tel. (223) 358866
Service Centre:
Beddington Lane, Croydon, Surrey CR9-4EN;
tel. (684) 3670

Greece: See Hellas

Hellas: Philips S.A. Hellénique,
54 Avenue Syngrou, P.O. Box 153,
Athens 403; tel. (1) 9215311

Hong Kong: Philips Hong Kong Ltd.,
P.O.B. 2108, St. George's Building, 21st floor,
Hong Kong city; tel. (5) 249246
Service Centre:
Hopewell Centre, 16th floor,
No. 17, Kennedy Road,
Wanchai, Hong Kong;
tel. (5) 283575

India: Peico Electronics & Electricals Ltd.,
S&I Equipment, Shivsagar Estate,
Block "A", Dr. Annie Besant Road,
P.O.B. 6598, Worli, Bombay 4000 18 (WB);
tel. 391431

Indonesia: P.T. Philips Development Corporation,
Jalan Let. Jen Haryone M.T. Kav. 17,
P.O.B. 2287, Jakarta-Selatan; tel. (21) 820808

Iran: Philips Iran Ltd., P.O.B. 1297, Teheran;
tel. 662281/5

Iraq: Philips Iraq W.L.L., Munir Abbas Building,
4th floor; South Gate, P.O. box 5749, Baghdad;
tel. 8880409

Island: Heimilisteaki SF, Saetún 8, Reykjavik;
tel. 24000

Islas Canarias: Philips Ibérica S.A.E.,
Triana 132, Las Palmas, Casilla 39-41,
Santa Cruz de Tenerife

Italia: Philips S.p.A., Sezione S&I/T&M;
Viale Elvezia 2, 20052 Monza; tel. (39) 36351

Japan: See Nippon

Jordan: Philips Delegate Office,
P.O. Box 35268, Amman; tel. 43998

Kenya: Philips (Kenya) Ltd.,
01 Kalou Road, Industrial Area,
P.O.B. 30554, Nairobi; tel. 557999

Kuwait: Delegate Office of Philips Industries,
P.O. Box 3801, Safat, Kuwait; tel. 428678

Lebanon: Philips Middle East S.A.R.L.,
P.O. Box 11670, Beirut, tel. 382300

Malaysia: Philips Malaysia Sdn Bhd.,
Lot 2, Jalan 222, Section 14,
Petaling Jaya, P.O. Box 2163, Kuala Lumpur,
Selangor; tel. 774411

México: Philips Mexicana S.A. de C.V.,
Div. Cientifico Industrial, Durango 167,
Apartado Postal 24—328, Mexico 7 (D.F.);
tel. 525 15 40

Morocco: S.A.M.T.E.L.,Casa Bandoeng,
B.P. 10896, Casablanca; tel. 303192

Nederland: Philips Nederland B.V.,
Hoofdgroep PPS, Boschdijk 525, Gebouw VB,
5600 VB Eindhoven; tel. 793333

Ned. Antillen: Philips Antilliana N.V.,
Postbus 523, Willemstad, Curaçao;
tel. 37575/37475

New Zealand: Philips Electrical Industries of N.Z. Ltd.,
Scientific and Industrial Equipment Division;
Wakefield Street 181-195,
P.O.B. 2097, Wellington C1; tel. 859859

Nigeria: Associated Electronic Products (Nigeria) Ltd.,
Ikorodu Road, P.O.B. 1921, Lagos; tel. 900160/61

Nippon: Nihon Philips Corporation,
Shuwa Shinagawa Building,
26-33 Takanawa 3 - Chome, Minato-Ku,
P.O. Box 13; Tokyo 108; tel (3) 448-5574/5511

Norge: Norsk A.S. Philips,
Industri og Forskning, Essendrops gate 5,
Postboks 5040, Oslo 3; tel. (2) 463890
Service Centre:
Postboks 1 Manglerud, Oslo 6; tel. (2) 294010

Oesterreich: Oesterreichische Philips Industrie GmbH,
Abteilung Industrie Elektronik,
Breitenfurterstrasse 219, A-1230 Wien;
tel. (222)-841611/15.

Pakistan: Philips Electrical Co. of Pakistan Ltd.,
El-Markz, M.A. Jinnach Road, P.O.B. 7101,
Karachi 3; tel. 70071

Paraguay: Philips del Paraguay S.A.,
Casilla de Correo 605, Asunción;
tel. 48045/46919

Perú: Philips Peruana S.A.,
Av. Alfonso Ugarte 1268
Apartado Aereo 1841, Lima 100, tel. 326070

Philippines: Philips Industrial Development Inc.,
2246 Pasong Tamo, P.O.B. 911,
Makati Rizal, 3116, Manila; tel. 868951/868959

Portugal: Philips Portuguesa S.A.R.L.,
Av. Eng.º Duarte Pacheco 6, Apartado 1331, Lisboa 1000;
tel. (19) 683121/9
Service Centre:
Servicos Técnicos Profissionais, Outurela,
2795 Linda-a-Velha; tel. (19) 2180071

Saoudi Arabia: Delegate Office Philips Industries,
Sabreen Bldg., Airport Road, P.O. Box 9844,
Riyadh; tel. 4777808/4778463

Schweiz-Suisse-Svizzera: Philips A.G.,
Allmendstrasse 140, Postfach, CH-8027 Zürich;
tel. (1) 432211/432629

Singapore: Philips Singapore Private Ltd.,
Lorong 1, Tao Payoh, 1st floor,
P.O. Box 340, Toa Payoh Central Post Office,
Singapore 1231; tel. (2) 538811
Service Centre:
403 Delta House, 4th floor,
No. 2 Alexandra Road,
Singapore 0315; tel. 2712555

South Africa: South African Philips (Pty) Ltd.,
2 Herb Street, New Doornfontein, P.O.B. 7703,
Johannesburg 2000; tel. (11) 6140411

South-Korea: Philips Electronics (Korea) Ltd.,
P.O. Box 3680, Seoul; tel. 794 4202

Suomi: Oy Philips Ab.,
Kaivokatu 8,
P.O. Box 10255,
00101 Helsinki 10; tel. 17271
Service Centre:
P.O. Box 11, SF-02631 Espo 63;
tel. 523122

Sverige: Svenska A.B. Philips,
Philips Industrielektronik, Lidingövägen 50,
Fack, S11584 Stockholm; tel. (8) 635000

Syria: Philips Moyen-Orient S.A., Rue Fardoss 79,
Immeuble Kassas and Sadate, B.P. 2442, Damas,
tel. 118605/221650/228003

Taiwan: Philips Taiwan Ltd.,
San Min Building, P.O. Box 22978, Taipei;
tel. (2) 5631717

Tanzania: Philips (Tanzania) Ltd.,
Box. 20104, Dar es Salaam; tel. 29571/4

Thailand: Philips Electrical Co. of Thailand Ltd.,
283 Silom Road, P.O. Box 961, Bangkok 5;
tel. 233-6330/9

Tunisia: S.T.I.E.T., 32 bis, Rue Ben Ghedhahem,
Tunis; tel. 244268/243025

Türkiye: Türk Philips Ticaret A.S.,
Posta Kutusu 504, Beyoglu,
Istanbul 1; tel. 435910

United Arab Emirates: Philips Delegate Office,
P.O. Box 2567, Dubai; tel. 220641/220642

Uruguay: Industrias Philips del Uruguay S.A.,
Avda Uruguay 1287, Casilla de Correo 294,
Montevideo; tel. 915641/44

U.S.A.: Philips Test and Measuring Instruments Inc.,
85, Mc Kee Drive, Mahwah, New Jersey 07430;
tel. (201) 529—3800

Venezuela: Industrias Venezolanas Philips S.A.,
Apartado Aereo 1167, Caracas 107;
tel. (2) 393811//353533

Zaire: S.A.M.E./S.Z.A.R.L., B.P. 16636, Kinshasa,
tel. 31887/8

Zambia: Philips Electrical Zambia Ltd.,
Mwenbeshi Road, P.O.B. 31878, Lusaka;
tel. 218511/218701

Zimbabwe: Philips Electrical (PVT) Ltd.,
62, Umtali Road, P.O. Box 994, Beverley/Salisbury;
tel. 47211

For information on change of address:
N.V. Philips' Gloeilampenfabrieken,
Test and Measuring Instruments Dept., Building TQIII-4,
5600 MD Eindhoven - The Netherlands

For countries not listed:
N.V. Philips, S&I Export Dept.,
Test and Measuring Instruments Dept., Building TQIII-3,
5600 MD Eindhoven - The Netherlands

T&M/811001

Positive feedback

Now you are the user of a Philips test and measuring instrument. We trust that it will give you many years of faithful service. But we would like you to realize one thing: we can only supply the best in T & M equipment with **your** help, user.
We need to know what you have found to be the strong and weak points of this instrument; and we would be very interested to hear about any unusual or elegant applications you have devised for it. Some of this information can be passed on to our design and development departments; and some may be fed back to other users via our bimonthly publication **T & M News.**
May we therefore suggest that you fill in the reply card alongside and send it back to us right now. That way, you'll be helping to provide the positive feedback we need to help you!
All contributions that are published will be paid for at current rates; while as an inducement for you to fill in the reply card, we are offering a free subscription to T & M News or a free copy of Part I of our Digital Instrument Course to all who reply.

Erfahrungsaustausch

Meßgeräte müssen sich in der Praxis bewähren und die in sie gesteckten Erwartungen erfüllen; auch bei Ihnen, dem Besitzer eines Geräts aus der Serie der Philips Test- und Meßgeräte. Wir aber können T & M-Geräte nur zu Ihrer vollen Zufriedenheit herstellen, wenn wir alle Ihre Wünsche kennen.
Deshalb interessiert uns Ihre Meinung über die guten und weniger guten Eigenschaften dieses Gerätes. Außerdem suchen wir Erfahrungen über ungewöhnliche oder neue Anwendungsmöglichkeiten. Vielleicht können Sie unseren Entwicklungs- und Konstruktionsabteilungen einen guten Wink geben; vielleicht können wir Ihre Erfahrungen aber auch in unserer Publikation **Info-dienst** (nur in Deutschland) veröffentlichen, damit auch andere Anwender davon profitieren können.
Deshalb möchten wir Sie bitten, die anhängende Antwortkarte auszufüllen und an uns zurückzusenden. Damit helfen Sie uns, und wir können Ihnen helfen!
Alle veröffentlichten Beiträge werden dem üblichen Tariff entsprechend honoriert. Als Dank für das Ausfüllen der Antwortkarte bieten wir Ihnen ein Freiabonnenment auf Info-dienst (nur in Deutschland) oder ein kostenloses Exemplar von Teil I von unserem Kursus Digital Instrument.

L'intérêt du "feedback"

Vous voilà possesseur d'un instrument d'essai et de mesure Philips. Nous espérons qu'il vous donnera de nombreuses années de bons et loyaux services, mais nous voudrions attirer votre attention sur un point: ce n'est qu'avec **votre** aide que nous pouvons fournir des matériels d'essai et de mesure de toute première qualité.
Nous avons besoin de savoir quels en sont les points forts et les points faibles que vous avez découverts et nous serions très intéressés d'apprendre quelles applications inhabituelles ou élégantes vous lui avez trouvé. Certains de ces renseignements peuvent être transmis utilement à nos bureaux d'études; certains autres peuvent être communiqués à d'autres utilisateurs par l'intermédiaire de notre publication **T & M Informations** (édition française seulement en France).
C'est pourquoi nous vous serions reconnaissants de remplir la carte-réponse à côté et de nous la renvoyer. De cette façon, vous contriburez à nous fournir le "feedback" dont nous avons besoin pour mieux vous servir!
Toutes les réponses publiées seront payées conformément aux tarifs en vigueur; pour vous inciter à remplir la carte-réponse, nous offrons un abonnement gratuit à T & M Informations ou un exemplaire gratuit de la première partie de notre cours sur les instruments numériques à tous ceux qui répondront.

Details of user: **Persönliche Angaben:** **Expéditeur:**

Company/
Firma/Société ....
Department/
Abteilung/Service ....
Street/Straße/Rue ....
Box/Postfach/Boîte Postale ....
City/Stadt/Ville ....
Country/Land/Pays ....
Name/Name/Nom ....
Phone/Telefon/Numéro de téléphone ....

Details of instruments: **Gerätedaten:** **Instrument:**

Name/Name/
Désignation ....
Type number/Typennummer/
Numéro de type ....
Serial number/Serienummer/
Numéro de série ....
Date purchased/Kaufdatum/
Date d'achat ....

What are the main applications for which you use this instrument?
Wofür verwenden Sie dieses Gerät hauptsächlich?
Quelles sont les principales utilisations auxquelles vous affectez cet instrument?

....
....

Please, list what you consider to be the **strong points** and the **weak points** of the instrument.
Zählen Sie bitte auf, was Ihrer Meinung nach die **guten Seiten** und was die **schwachen Stellen** dieses Geräts sind.
Veuillez énumérer ce que vous considérez être les **points forts** et les **points faibles** de l'instrument.

....
....
....

Do you have any queries about the use of this instrument? If so, what?
Haben Sie irgendwelche Fragen über die Anwendung dieses Geräts? Wenn ja, welche?
Avez-vous des questions à poser sur l'emploi de l'instrument? Si oui, lesquelles?

....
....
....

I have devised an interesting application for this instrument.
- ☐ I enclose a brief description (up to about 500 words) of this application
- ☐ Please send a representative to collect information about the application

Ich habe einen interessanten Verwendungszweck für dieses Gerät gefunden.
- ☐ Eine kurze Beschreibung hiervon (max. ca. 500 Wörter) erhalten Sie anliegend.
- ☐ Senden Sie bitte jemanden, der sich an Ort und Stelle über den Verwendungszweck informieren kann.

J'ai trouvé une application intéressante pour cet instrument
- ☐ Je joins une brève description (500 mots environ au maximum) de cette application.
- ☐ Veuillez envoyer un représentant à qui nous donnerons des renseignements sur l'application.

- ☐ I would like to receive **T & M News** regularly.
- ☐ Please send me Digital Instrument Course Part I.
- ☐ Ich möchte **Info-dienst** regelmäßig beziehen.
- ☐ Senden Sie mir Digital Instrument Course, Teil I.
- ☐ J'aimerai recevoir **T & M Informations** régulièrement.
- ☐ Envoyez moi la première partie du cours sur les instruments numériques.

PHILIPS

T & M News
N.V. PHILIPS' GLOEILAMPENFABRIEKEN
S & I TQ III - 4
Test and Measuring Instruments Department
Att. Mr. T. Sudar
EINDHOVEN
The Netherlands

please fold

T & M News is your feedback unit

T & M News is a bimonthly publication issued by the T & M Measuring Department of Philips' Science & Industry Division, for distribution to actual and potential users of Philips' T & M equipment. It provides an effective means of exchanging information in the T & M field - both from the manufacturer to the customer and **vice versa.**
Apart from **T & M News** itself, we also issue **T & M Reports,** which provide a vehicle for (generally longer) articles of a more specialized and/or theoretical nature to supplement the information given in **T & M News.** These Reports, being of a more specialized interest, are generally sent to a more restricted group of users; though anyone who is interested can obtain them on request.
One special series that was brought out in supplements to T & M News is our Digital Instrument Course (Part I: Basic binary theory and logic circuits; Part II: Digital counters and timers; Part III: Digital voltmeters and multimeters; Part IV: IEC Bus Interface), which proved so popular with readers that each part of the course has been issued in booklet form.

Info-dienst für Ihren Erfahrungsaustausch

Info-dienst (nur in Deutschland) ist eine Publikation der Philips GmbH Unternehmensbereich für Elektronik für Wissenschaft und Industrie für die jetzigen Besitzer und potentiellen Kunden von Philips T & M-Geräten. Dieses Blatt strebt einen effektieven Informationsaustausch auf dem T & M-Gebiet zwischen Hersteller und Anwender sowie **umgekehrt an.**
Neben diesen **Info-dienst** geben wir auch die **T & M Reports** heraus (nur in englischer Sprache), in denen (im allgemeinen längere) Artikel mehr spezieller bzw. theoretischer Art als Ergänzung zu den Informationen in **Info-dienst** stehen. Diese Reports, an denen in allgemeinen nur Spezialisten interessiert sind, werden an eine begrenzte Anwendergruppe verteilt. Jeder, der daran interessiert ist, kann sie auf Anfrage erhalten.
Eine spezielle Serie, die gerade in den T & M News Supplements erschienen ist, war unser Digital Instrument Course (Teil I: Basic binary theory and logic circuits; Teil II: Digital counters and timers; Teil III: Digital voltmeters and multimeters; Teil IV: IEC Bus Interface). Diese Serie war bei den Lesern so populär, daß jeder Teil von diesem Kursus auch in Buchform herausgegeben wurde (nur in englischer Sprache).

T & M Informations est notre moyen de communiquer mutuellement

T & M Informations est une publication de département de Mesure de Philips, destinée aux utilisateurs effectifs et un puissance d'appareils d'essai et de mesure Philips. Elle constitue un moyen efficace de transmettre de l'information dans ce domaine, aussi bien du fabricant vers le client que **vice versa.**
A part la publication **T & M Informations proprement dite,** nous diffusons les **T & M Reports** (seulement en anglais) qui contiennent des articles (généralement plus longs) de nature plus spécialisée ou plus théorique, destinés à compléter l'information donnée dans **T & M Informations.** Etant donné leur nature, ces Reports ne sont généralement envoyés qu'à un cercle plus restreint d'utilisateurs; toutefois, quiconque s'y intéresse peut les obtenir sur demande.
Nous venons de publier dans les T & M News Supplements une série spéciale d'articles qui constituent un cours sur les instruments numériques (1ère partie: Théorie binaire de base et circuits logiques; 2ème partie: Compteurs numériques et minuteries; 3ème partie: voltmètres et multimètres numériques; 4ème partie: IEC Bus Interface) qui a rencontré un tel succés auprès des lecteurs que chaque partie du cours a été réimprimée sous forme de livret (seulement en anglais).

9498.825.016

PHILIPS

SERVICE

Cryogenic Equipment / Electro Chemistry / Electron Optics / Electronic Weighing / Industrial Data Systems / Numerical Control / Philips Pollution Measuring / Radiation Measuring Equipment / Test and Measuring Equipment / Welding Equipment / X-Ray Analytical Equipment

equipment for science and industry

810101 TEST AND MEASURING EQUIPMENT OSC76

OSCILLOSCOPE PM3266/01, 02, 03

Already published: OSC53, 54, 62, 71, 72.

Subject: Alterations in CRT-specification and resulting modifications in circuitry of focus unit (unit 7) and Z-amplifier (unit 11).

Contents of this info sheet:

1. Introduction.
2. Alterations in CRT-specification.
3. General review of modifications required for an instrument in case of CRT-replacement.
4. Modifications in the /01 and /02 production series.
5. Modifications in the /03 production series.
6. Final remarks.

NOTE: Fig. 9 shows a diagram, that indicates the modifications of CRT, Z-amplifier and focus unit as a function of instrument number and/or production series.

9499 448 15111

PRINTED IN THE NETHERLANDS

1. INTRODUCTION

With this info sheet you are able to find the modifications that are necessary for your instrument in case of CRT-replacement. The required modifications depend on the production series and/or instrument number of the oscilloscope. Every instrument has an instrument number and a production series number. Both numbers are indicated at the identification plate at the rear of the instrument. An instrument with for instance the code DQ 02–730 at the identification plate is from the /02 production series and has instrument number 730.

2. ALTERATIONS IN THE CRT-SPECIFICATION

The alterations concern the cut-off voltage between cathode and G1 and the leakage current of vertical focusing electrode G5.

2.1. Cut-off voltage

The cut-off voltage is the minimal required negative voltage on the Wehnelt-cylinder G1 (compared with the cathode-voltage) that is able to suppress the beam-current inside the CRT. The CRT's that have been installed in the PM3266 have had, in sequence of time, cut-off voltages of 100 Volt, 115 Volt and 125 Volt.

2.2. Leakage current on vertical focusing electrode G5

Due to a modification of the electrode system of the CRT the leakage current of G5 increased from 4 μ A maximal to 40 μ A maximal.

3. GENERAL REVIEW OF MODIFICATIONS REQUIRED FOR AN INSTRUMENT IF A NEW CRT IS INSTALLED

The CRT's delivered by Concern Service have a cut-off voltage of maximal 115 Volt and a leakage current of maximal 40 μ A. These CRT's have ordering code 5322 131 24053 and have had an extensive test. If such a CRT is installed in an instrument with cut-off voltage of 100 Volt and/or able to compensate for 4 μ A from G5 the focus unit (unit 7) and Z-amplifier (unit 11) must be adapted:

- Because of the inscreased cut-off voltage the focus unit needs modification: besides some small modifications the stabilisation tube V2078 of 103 Volt must be replaced by a 116 Volt type. Also a new unit 7 can be installed (ord. code 5322 216 54217). This unit is already modified.
  Also small modifications on the Z-amplifier are necessary.
- Because of the increased leakage current on G5 the circuitry on the additional small unit on the Z-amplifier must be modified: an extra transistor and some other components must be added. Also a new additional small unit can be installed.

In order to make the above mentioned modifications possible, the CRT's from Concern Service used to be delivered with a modified focus unit, a modified additional small unit for the Z-amplifier and an information paper HN/IS/1498. The information paper pointed out how to adapt older instruments to a new CRT with the use of the two modified units. From now on, however, the CRT's are again delivered without 2 units and the info sheet. Instead of this the following arrangement has been made:

- The CRT is delivered with this service info sheet OSC76.
- Most National Organisations will receive a quantity of focus units and additional small units; this number will be sufficient to modify all the instruments in their area that need modification in case of CRT replacement.
- Other National Organisations can order the necessary units at the Supply Centre Service Group in Enschede, The Netherlands. When ordering the units for a particular instrument, the instrument number and the production series number must be mentioned.

4. MODIFICATIONS IN /01 AND /02 SERIES NECESSARY TO ADAPT THE INSTRUMENT FOR A NEW CRT

4.1. PM3266/01 production series

The electronic circuitry is able to work with CRT's with a cut-off voltage of 100 Volt and a leakage current on G5 of 4 μA.

4.2. PM3266/02, the first instruments of this production series

The electronic circuitry is able to work with CRT's with a cut-off voltage of 115 Volt and a leakage current on G5 of 4 μA.

4.3. Instrument numbers in PM3266/01 and /02 production series that need modification in case of CRT replacement

Versions mentioned in chapter 4.1 and 4.2 have the following instrument numbers:
- For PM3266: from instrument number DQ601 up to DQ725 approximately.
- For PM3266Q (USA-version): from instrument number DQ601 up to DQ613 with the exception of DQ609

For the oscilloscopes with the instrument numbers mentioned above as modified focus unit and a modified additional small unit for the Z-amplifier is necessary if a new CRT is installed. For this also refer to chapter 3. Also some small modifications of the Z-amplifier are necessary. After this the instrument has been modified according to the circuit diagram in fig. 1. The components in this diagram that are modified or added compared with fig. 3.63 in manual 9499 440 19702 are indicated with a dot. The p.c.b. lay-outs of the modified focus unit (unit 7) and the Z-amplifier (unit 11) are indicated in respectively fig. 2 and fig. 3.

4.4. PM3266/02, recent instruments from this production series

The instrument in the /02 series, that are already modified are:
- For PM3266: from approximately instrument number DQ726 and up.
- For PM3266Q: from instrument number DQ613 and up and for instrument number DQ609.

In the instrument with the instrument numbers mentioned above, a new CRT can be installed without modifications in the circuitry. However, it may be useful to check if all the modifications marked with a dot on the circuit diagram in fig. 1 are present on the Z-amplifier (unit 11).

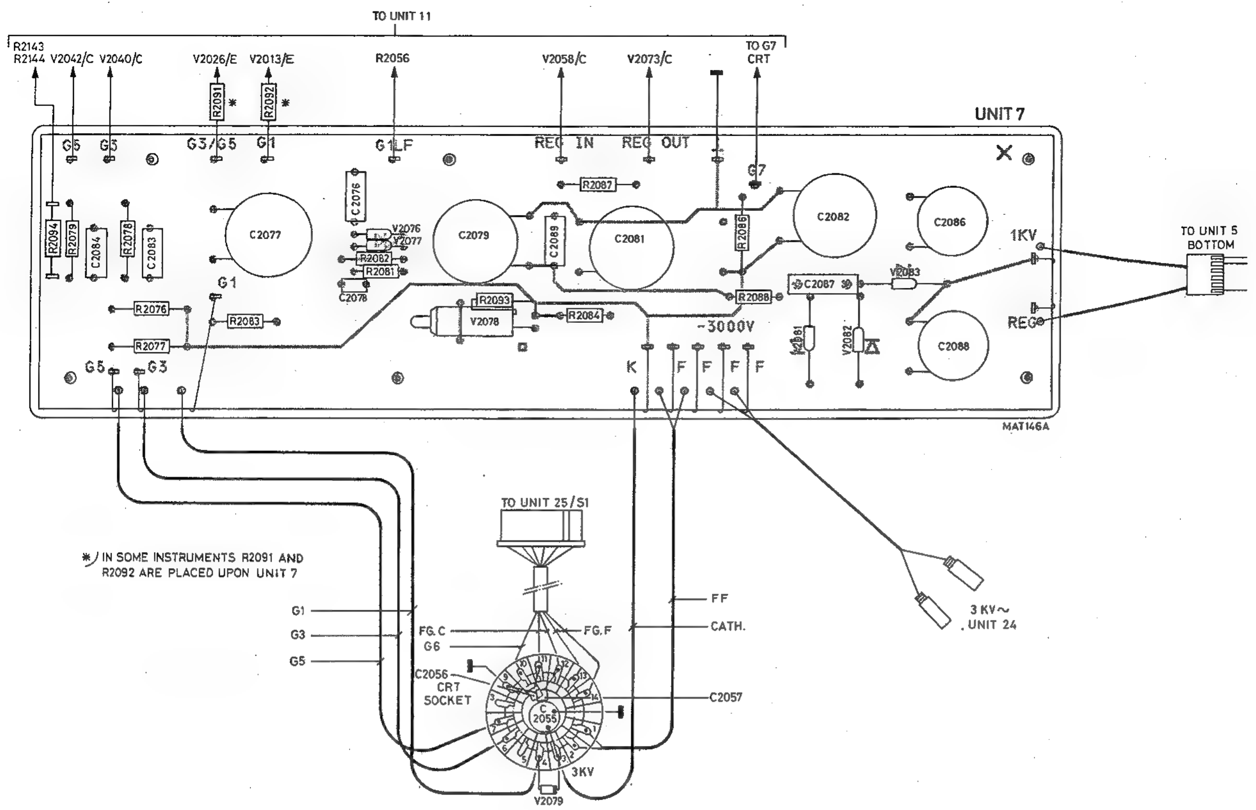


Fig. 2. P.c.b. lay-out of focus unit (unit 7) for /01 and /02 series

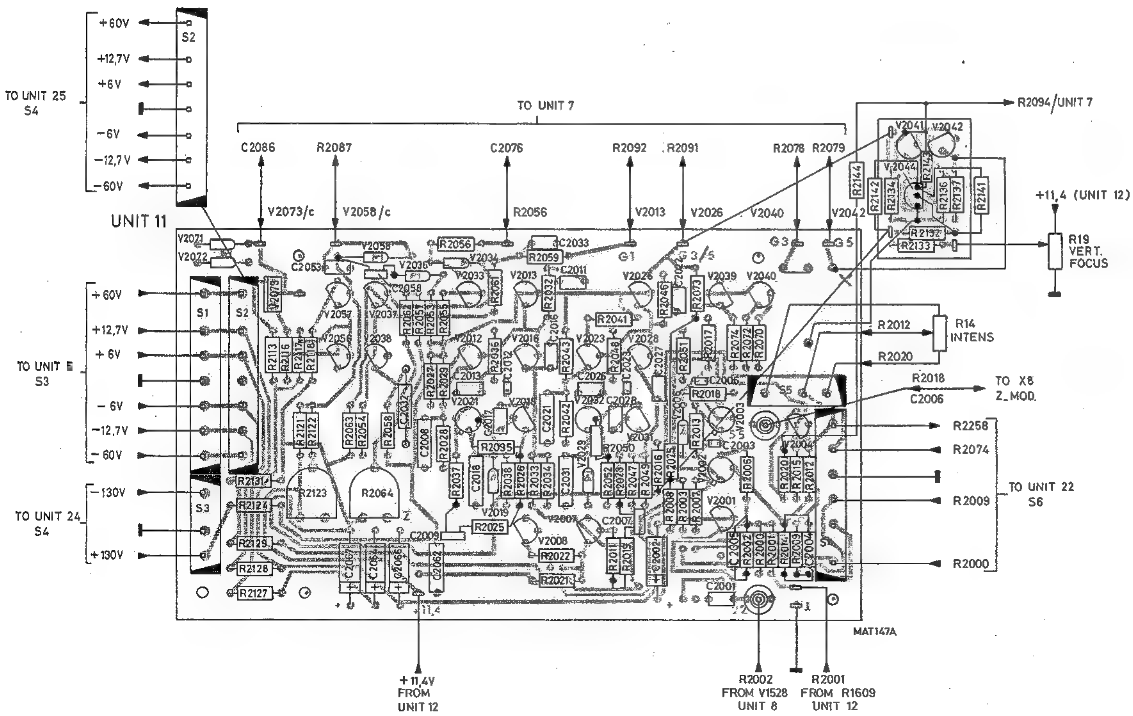


Fig. 3. P.c.b. lay-out of Z-amplifier (unit 11) for /01 and /01 series

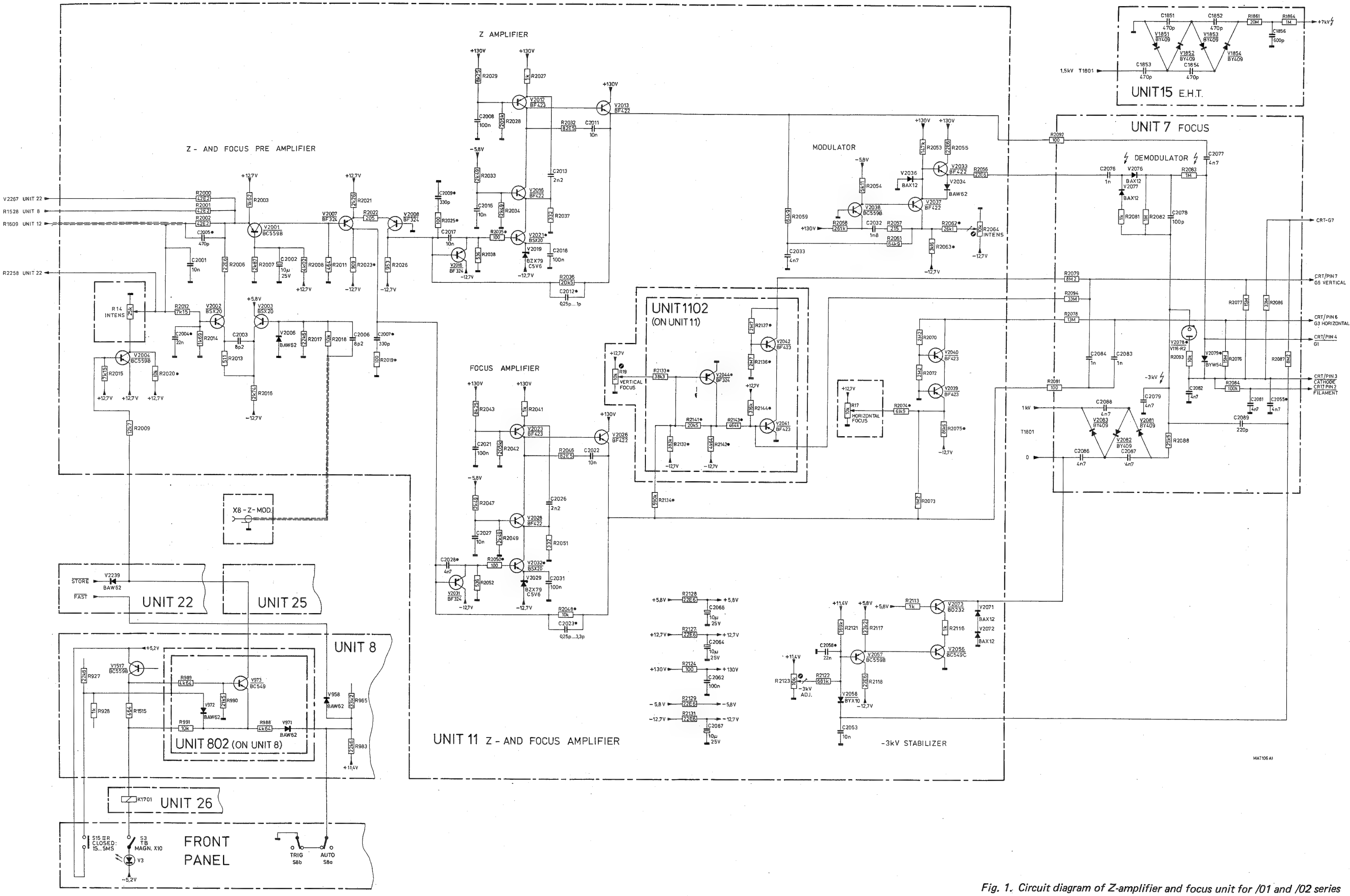


Fig. 1. Circuit diagram of Z-amplifier and focus unit for /01 and /02 series

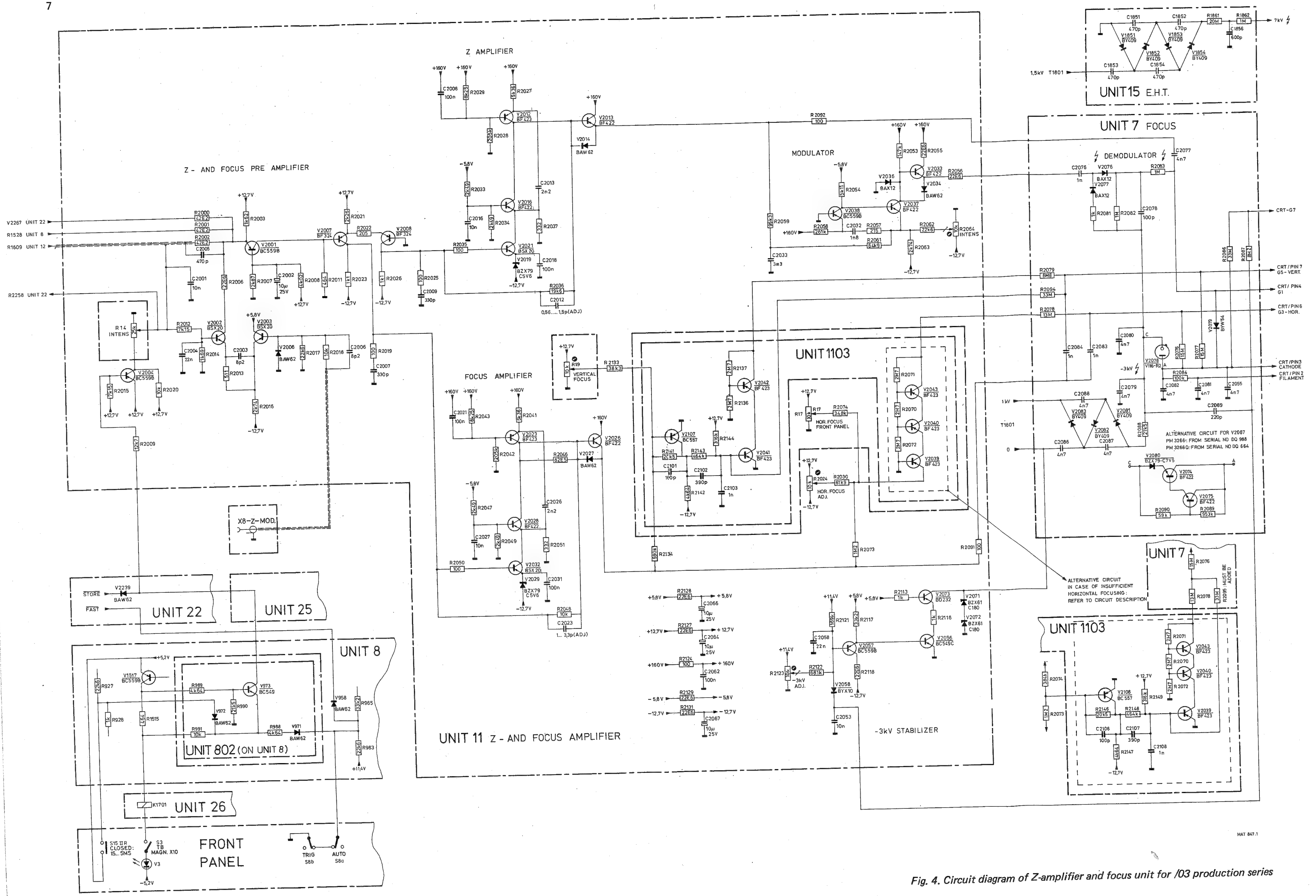


Fig. 4. Circuit diagram of Z-amplifier and focus unit for /03 production series

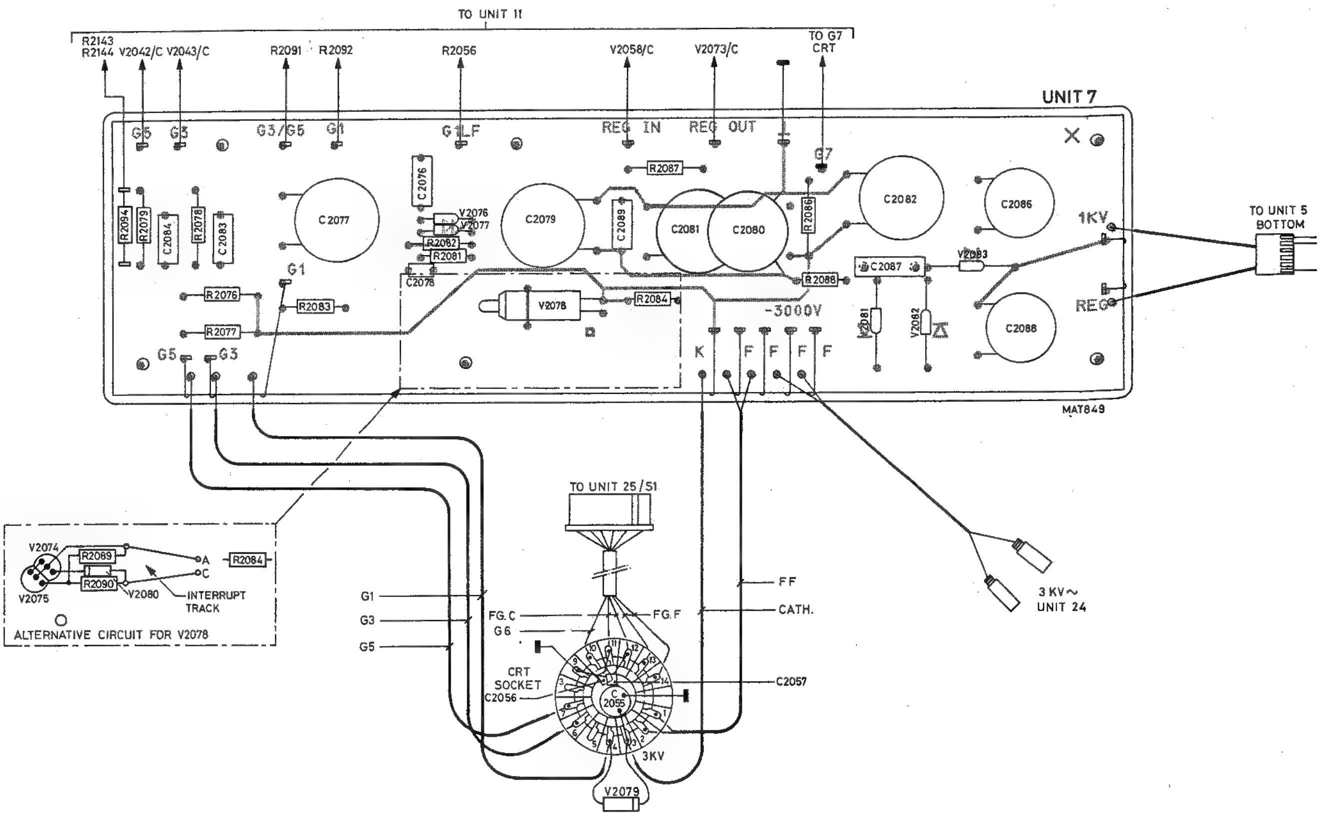


Fig. 5. P.c.b. lay-out of focus unit (unit 7) for /03 production series

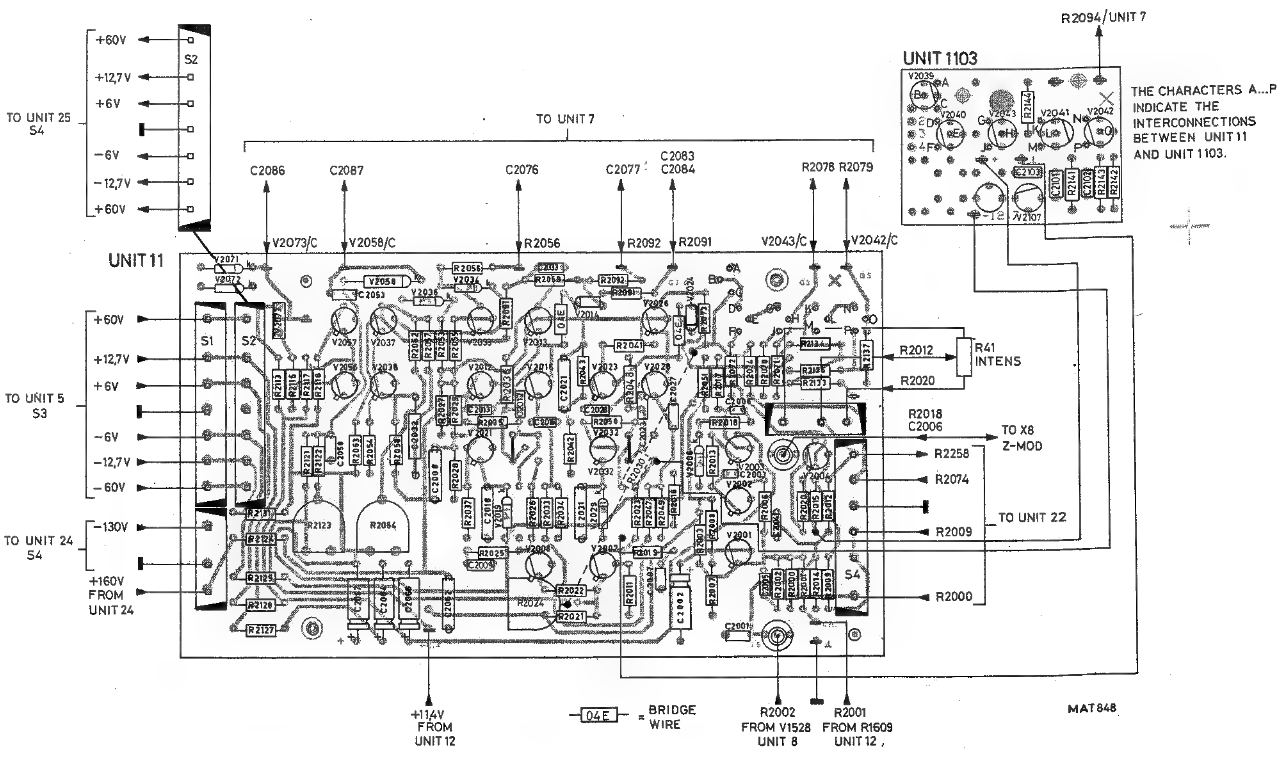


Fig. 6. P.c.b. lay-out of Z-amplifier (unit 11) for /03 production series

5. MODIFICATIONS IN THE /03 PRODUCTION SERIES

5.1. Instruments with instrument numbers up to and included DQ987 for PM3266 and DQ663 for PM3266Q

The circuit diagram (fig. 4) of focus unit (unit 7) and Z-amplifier (unit 11) is almost identical to the diagram of recent instruments of the /02 series and already modified older instruments. However, there are some differences. The Z-amplifier (unit 11) has a new lay-out which is indicated in fig. 6. Also the additional small unit (unit 1103) on the Z-amplifier has a new lay-out (also in fig. 6).
On this small unit the circuitry for the control of the vertical focusing electrode G5 of the CRT is able to compensate for currents up to 40 μA. The circuitry for the control of the horizontal focusing electrode G3 of the CRT is able to compensate for currents up to 20 μA. If, due to possible CRT modifications, this current should increase to a value higher than 20 μA an additional modification of unit 1103 is necessary. This modification is pointed out in chapter 5.4. It is expected, however, that this modification will not be necessary. The circuit diagram (fig. 4) indicates the standard circuit for control of G3 with the active components V2039, V2040 and V2043. Also the alternative circuit for G3 control is indicated in fig. 4: the active components are V2108, V2039, V2040 and V2043.
The first instruments from the /03 production series with instrument numbers up to and included DQ987 for PM3266 and DQ663 for PM3266Q can accept CRT's with a cut-off voltage of 115 Volt and a current on G5 of 40 μA. So CRT's delivered from Concern Service can be installed without problems.
For ordering numbers of units see fig. 8.

5.2. Instruments with instrument numbers from DQ988 for PM3266 and from DQ664 for PM3266Q

These instruments have a new focus unit (unit 7). On this focus unit an electronic circuit with V2074, V2075 and V2080 is used instead of the neon stabilisation tube V2078. The electronic circuit functions as a zener diode of 130 Volt approximately. The neon stabilisation tube V2078 has a zener voltage of 116 Volt. The new focus unit with alternative circuit instead of V2078 is indicated in the circuit diagram in fig. 4.
The lay-out of the new focus unit on which also the alternative circuit is shown is indicated in fig. 5.
The oscilloscopes equipped with this new focus unit can accept CRT's with a cut-off voltage of 125 Volt.
For replacement, CRT's from Concern Service can be used without problems.
For ordering numbers of units see fig. 8.

5.3. Modifications on the additional power supply (unit 24)

If you compare the circuit diagram of Z-amplifier and focus unit of the /01/02 series (fig. 1) with the diagram of the /03 series (fig. 4) one of the differences is that the +130 Volt supply for the Z-amplifier changed into +160 Volt in the /03 version.
Both the +130 Volt and the +160 Volt are delivered by the additional power supply (unit 24). Due to the fact that the supply for the Z-amplifier has changed from +130 Volt to +160 Volt the current drain from the +130 Volt decreased. As a result the +130 Volt tends to rise to +150 Volt approximately. In order to bring this voltage back to +130 Volt the following modifications are possible:

- Replace L1877 (20mH) by a type with a higher selfinductance (140mH). This solution will be carried out in the /04 production series.
- Connect a diac V1885 (BR100) between V1881/V1886/cathode and L1877. The diac is a device that becomes conductive if the voltage across it is higher than 32 Volt. This solution is used in the instruments of the /03 series and it is indicated in fig. 7.

5.4. Modifications necessary in case of horizontal defocusing

This modification will not be necessary as far as it is expected now. However, in case of horizontal defocusing after CRT-replacement the necessary modifications are available. These modifications must mainly be carried out on unit 1103. The necessary space for the new components is already available on unit 1103. The modified unit is indicated in fig. 8. The circuit diagram of the modified unit is indicated in fig. 4 as "alternative circuit in case of insufficient horizontal focusing".
For the modification proceed as follows:
- Add a transistor V2108/BC557: ord. code 4822 130 44256.
- Add a resistor R2146/20K5/MR25: 5322 116 54643.
- Add a resistor R2147/4K64/MR25: 5322 116 50484.
- Add a resistor R2148/464K/MR25: 5322 116 54759.
- Add a resistor R2149/316K/MR25: 5322 116 55268.
- Add a capacitor C2106/100pF: 4822 122 31211.
- Add a capacitor C2107/390pF: 4822 122 31176.
- Add a capacitor C2108/1nF: 4822 122 31175.
- Remove interconnection 2 + 3.
- Add interconnections 1 + 2 and 3 + 4.
- Remove V2039 and remount it in its socket as indicated in fig. 8.
- Remove R2075 from the Z-amplifier (unit 11).
- Add a resistor R2095/33M/VR37 on the focus unit (unit 7): ord. code 4822 110 42227.

6. FINAL REMARKS

6.1. Diagram, showing the modifications of CRT, Z-amplifier and focus unit

The diagram is shown in fig. 9 and indicates the ordering codes of units that are required for the various instruments as a function of production series and/or instrument number.
In case of replacement of a focus unit in a /03 series instrument with instrument numbers up to and included DQ987 for PM3266 or DQ663 for PM3266Q it is advisible to use the new focus unit 5322 216 51002 for replacement.

6.2. Readjustment of Z, focus and storage section

It is obvious that after having replaced a unit from the instrument the performance must be checked.
If necessary readjustments must be made.

6.3. Parts list

V2074, V2075 (BF422)	: 4822 130 41084	unit 7 /03 series
V2080 (BZX79/C7V5)	: 4822 130 30861	
R2090 (59K/MR25)	: 5322 116 54678	
R2089 (953K/MR25)	: 5322 116 55257	
L1877 (20mH)	: 5322 152 24068	unit 24 /03 series
V1885 (BR100)	: 4822 130 20039	
L1877 (140mH)	: 5322 152 24071	unit 24 /04 series

In future, the instruments will be equipped with a new rear cabinet plate that replaces the rear cabinet plate with ordering code 5322 447 94503.
The new rear cabinet plate has a round plastic cap opposite to the CRT-socket, which gives a better isolation. The ordering code of the new rear plate, that also fits on /01 and /02 series instruments, is 5322 447 90001.

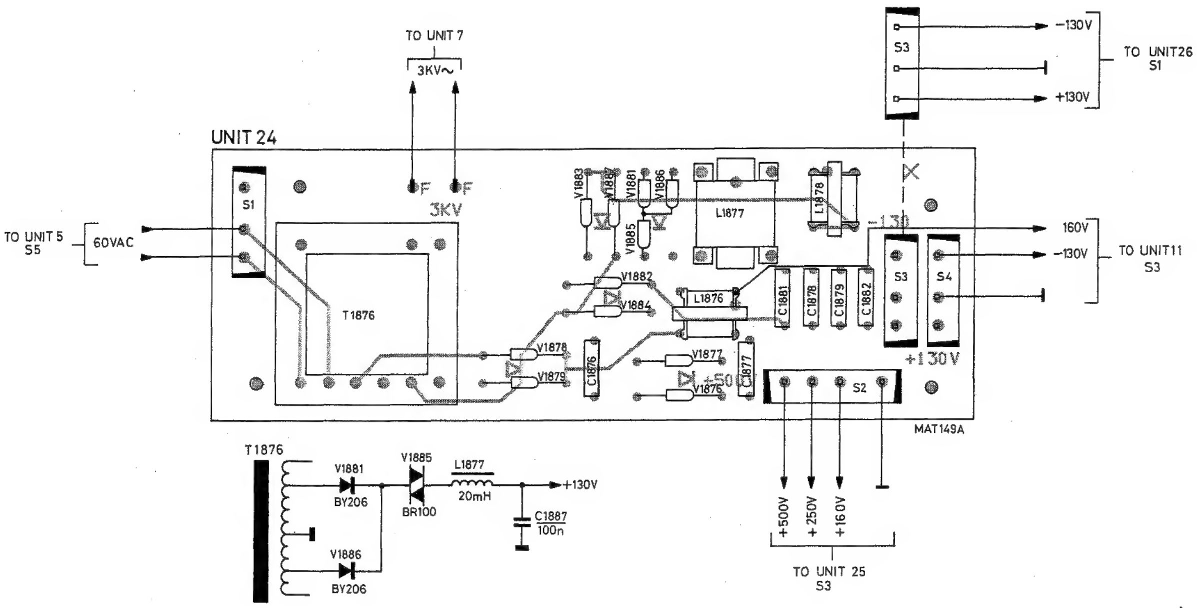


Fig. 7 P.c.b. lay-out of additional power supply (unit 24)

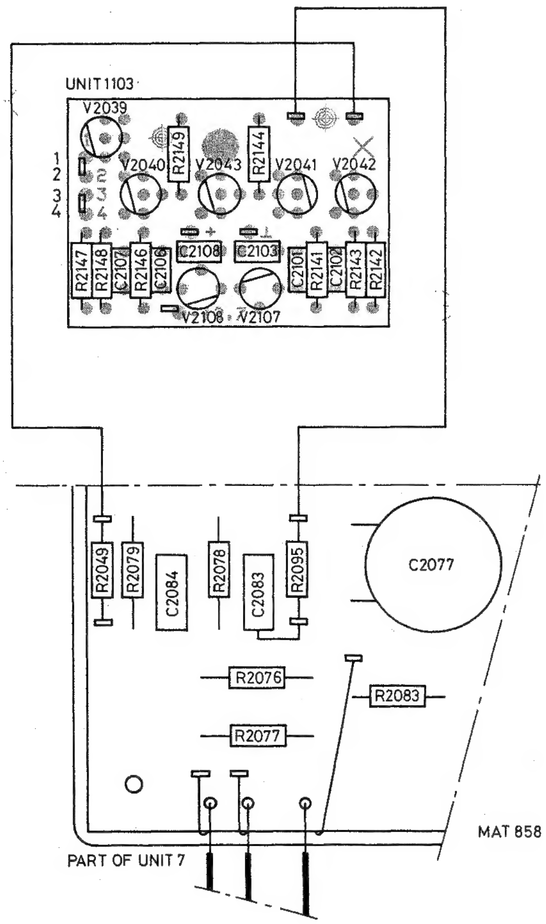


Fig. 8 P.c.b. lay-out of unit 1103 with alternative circuit

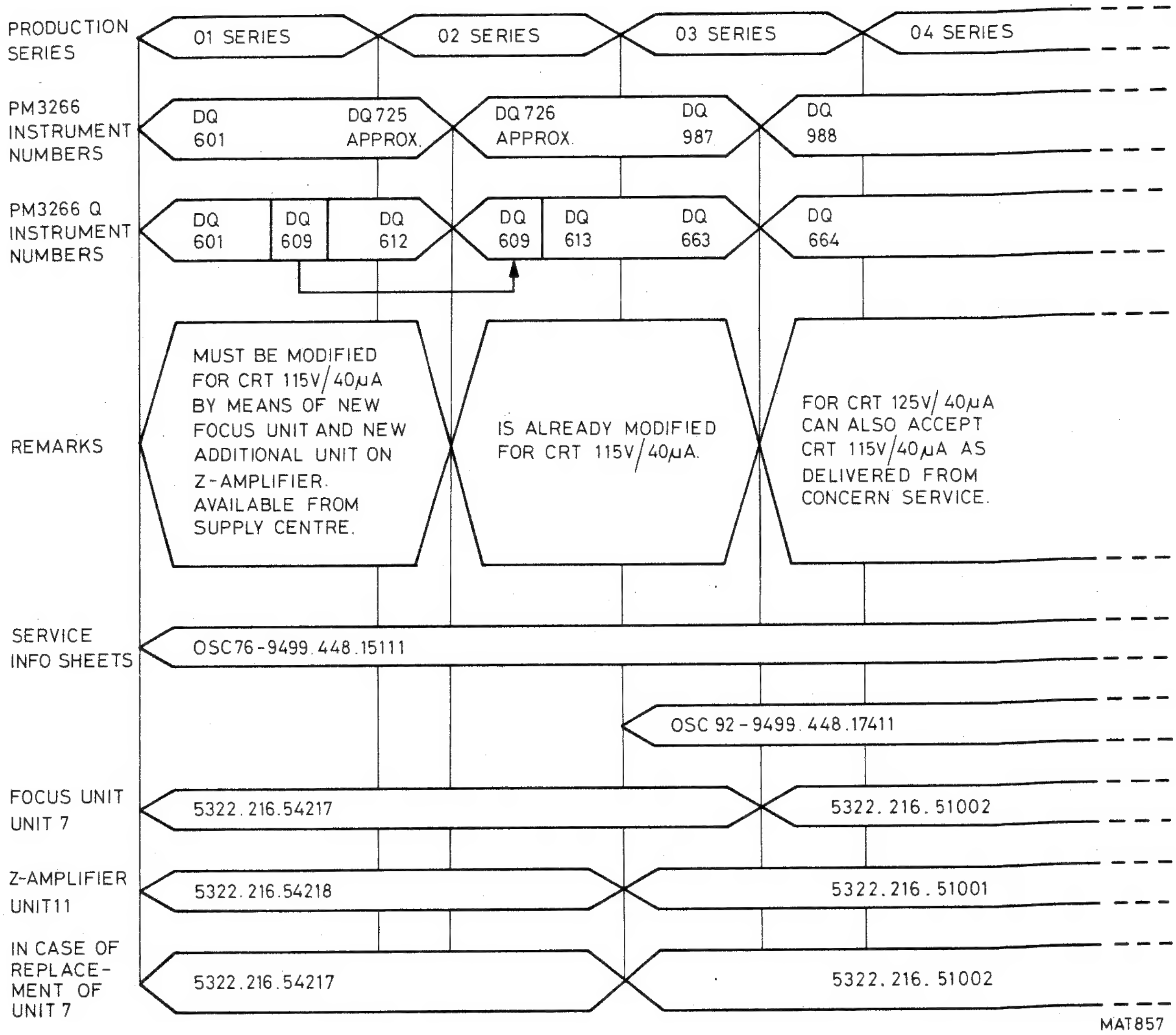


Fig. 9 Diagram showing the modifications of CRT, Z-amplifier and focus unit